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PAPERS READ

BEFORE THE

ROYAL GEOGRAPHICAL SOCIETY.

I.—*Congelation of the Neva at St. Petersburgh, and Temperature of its Waters when covered with Ice.* Communicated by Colonel Jackson, F.R.G.S. (St. Petersburgh.) Read 12th of January, 1835.

THE physical phenomena of nature, for the most part general, are found, in various parts of the world, to be greatly modified, and sometimes wholly counteracted, by local causes. To study, therefore, with advantage the laws of such phenomena, and their mode of action, it is necessary to observe them in those places where they act with the greatest energy, and are the least controlled; whence the utmost effects of solar heat[*] should be studied in the inter-tropical regions of the globe; while congelation and other effects of refrigeration should be examined in the neighbourhood of the polar circles.

St. Petersburgh, though not the most northern of capitals, is undoubtedly the coldest.[†] Here, then, may the phenomena of cold be studied with the least possible inconvenience; and from this city the learned have a right to expect information on all the facts connected with this branch of general physics.

These considerations have induced me to profit by my residence in the capital of the Russian empire, to observe the gradual congelation of the Neva, in conjunction with the temperature of the atmosphere; as also the temperature of the waters of the river when it is covered with a surface of ice.[‡] Many circumstances tend to complicate the problem of the congelation of running waters; and I have thought that my observations might have some interest, either as presenting new facts, or as corroborating such as may be already known, or, finally, as presenting anomalies sometimes more interesting than the regular phenomena themselves.

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[*] We must not confound *the effect* of solar heat with the *temporary intensity of the solar radiation,* which is found to be much greater in the northern regions than under the equator.

[†] The mean *maximum* cold at St. Petersburgh is − 21·4 of Reaumur, though it has sometimes come down as low as − 30·2. The mean temperature of the year is + 3°, while that of Christiania, under the same parallel, is + 5°. Drontheim, three degrees more to the north, has a less rigorous climate.

[‡] I am not aware that any similar observations have been ever made.

Previous, however, to a statement of my observations, it may be necessary to remind the reader of the topography of the river.

The Neva, though it be called a river, is more properly a Bosphorus or strait. Its length from Schlusselberg, at the S.W. angle of the Ladoga Lake, to its mouth, is 69 versts;* its direction that of a straight line from E. to W.; its medium breadth about 1500 feet; and its depth, in many places considerable, is generally, in the channel, about 50 feet. The water of the Neva is remarkably pure, and though the first use of it by strangers generally produces slight diarrhœa, yet it is very wholesome and extremely palatable.

This fine river is the grand and only outlet for the superabundant waters of four great basins, each of which has an extensive natural reservoir of its own. These reservoirs are the lakes Onega, Ilmen, Saïma, and Ladoga; the latter receiving the drains of the other three. Ten different streams flow into the Onega, whose length, from N. to S., is 190 versts; and its breadth, from E. to W., 70. It discharges into the Ladoga by the Sveer, a river 202 versts long and of very unequal breadth, being in some places only 210 feet wide, and in others spreading to a breadth of 2 versts.

The Ilmen is 55 versts long from N.E. to S.W., and about 30 wide from N.W. to S.E. It receives eleven streams, and has its outlet into the Ladoga by the Volkoff, 206 versts long, with a medium breadth of 1400 feet.

The Saïma, which is rather a collection of lakes, of gulfs, and bays of all shapes and sizes communicating with each other, than a regularly formed and single sheet of water, is estimated by Peter Friccius at 130 versts long in the direction of W.S.W. to E.N.E., and 120 from N. to S.; but on the Swedish side, it is about 280 versts more. It pays its tribute to the Ladoga by means of the Voksha or Voxa, a river about 180 versts long, very irregular both in direction and breadth, and not navigable in consequence of its several cascades, of which the most considerable, that of Imatra, has a fall of upwards of 32 feet.

Besides the Sveer, the Volkoff, and the Voxa, the Ladoga receives the waters of thirteen other streams. This, the largest lake of Europe, is about 175 versts long and 105 broad, and of an oval form.

The surfaces of the four lakes are thus estimated—

The Onega . . .	430	leagues of 25 to the degree.
The Ilmen . . .	36	„
The Saïma . . .	210	„
The Ladoga . .	830	„
	1506	

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* The Russian *verst* is 3500 English feet.

From such an accumulation of waters, on which evaporation, however intense the solar heat while it lasts, acts but during three or four months in the year, it is natural to expect an immense outflowing: and accordingly we find the Neva carry into the gulf of Finland upwards of 116,000 cubic feet of water in a second,* a fraction of which proceeds from eight small, though partly navigable, rivers, which fall into it during its course from the Ladoga to St. Petersburgh. The ordinary velocity of the river is about 37 inches per second.

At St. Petersburgh the Neva divides itself into several *deltoidal* branches, the largest of which, at the place where the observations which form the subject of the present notice were made, is 1260 feet broad; and bears along a mass of about 74,000 cubic feet of water in a second, while the Nile, in the same time, furnishes but 21,800 cubic feet.†

That such a body of water, moving at the rate of about 2 miles and 1 furlong in an hour, should be annually covered with a sheet of ice seldom less and often more than three feet thick, while the mean temperature of the air during the winter months is seldom lower than − 4·5° of Reaumur's thermometer, appears surprising; nor could it happen but for the combination of two circumstances, neither of which would be alone sufficient: these are, the drift ice from the Ladoga, and the long duration of the winter.

The drift ice from the Ladoga generally comes down about the middle of November, sometimes in October, and sometimes, though more rarely, not till December. The cold is so sudden and so violent, that twenty-four hours are sufficient to form round the edges of the northern lakes a cake of ice from 2 to 5 inches thick, which is almost as soon broken up by the storms to which these lakes are subject. This event is immediately announced to St. Petersburgh by telegraph. The police are on the look-out, and in about twenty-four hours, more or less, the arrival of the first flakes gives the signal for removing the bridges of boats, by which the communication across the river is established. Soon after, large sheets of ice come floating down and announce the setting in of the winter. At this time one of the bridges‡ is frequently removed and replaced, to the great inconvenience of the inhabitants of the capital. Vehicles of every description remain crowded on either bank, while large boats, loaded with passengers, are seen forcing their way through shoals of drifting ice, by which they are often carried down a considerable distance. It is now impossible to replace the bridge, the passage becomes more and more difficult for the boats, and is finally interrupted altogether. Unhappy, then, are those whom affection, business, or pleasure call to the opposite side: the distance is only a few paces, but the passage is impracticable.* This painful suspense lasts a few days, seldom a week.

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* This result was obtained by admeasurement executed with the greatest care and scientific skill by Lieutenant-Colonel Henry, under the direction of Colonel, now Major-General, Destrein, in the year 1826, in order to have the data requisite for devising a means of securing the capital of Russia from the disastrous effects of the inundations to which it is unhappily subject.

† According to the admeasurements of Monsieur Girard, a French engineer.

‡ We say *one of the bridges*, because, although there are several which cross the different branches of the Neva, there are only two over the main trunk, and of these one only can be conveniently manœuvred. The other, from its great length (2730 feet), cannot be so easily managed, and therefore, when once taken away, is not again replaced during the whole winter. The one of which we speak as being frequently removed, termed the Isaac bridge, is on pontoons, and is now manœuvred with

If the lake ice has been broken into small pieces, these sometimes pass on to the gulf without encumbering the river, and when they are all gone by, the bridge is replaced, and things remain as before till the arrival of a fresh batch. If, on the contrary, the flakes are large, they get jammed one against the other, and not only remain fixed themselves, but arrest the progress of the succeeding masses. Between them, however, are large spaces quite clear of ice. In this state, a violent wind is sometimes sufficient again to detach and break the flakes and allow them to proceed, when the river again becomes free. This, however, is not frequent; and, as we have said, when the large flakes fix, the communication is for a while wholly interrupted, not that the ice will not bear, but because of the unfrozen spaces, so much the more dangerous as they are smaller, for then a pellicle of ice being soon formed they become covered with snow and are hidden.

The ice being now firmly fixed, a number of men are set to work to clear away the space immediately below the bridge; it is

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great celerity. Its length is 924 feet, and it is formed of fifteen pontoon boats. This bridge, being cast loose at both ends, swings round against one side, by the current, in about a quarter of an hour, and by means of capstans and warps is again replaced in less than two hours. Formerly the operation of replacing the bridge lasted several days, both in consequence of a defective method and want of skill, and by reason of the bribery employed by the boatmen of the river, who paid in common a considerable sum in order to enjoy the monopoly of the passage across as long as possible.

* The interruption of the communication across the Neva is attended with the greatest inconvenience, for, independent of the ordinary passage to and fro of the multitude in a large city, the Exchange, the Custom-house, the Academies of Sciences and the Fine Arts, the Corps of Cadets of the army and navy, together with other government departments, as also the principal cemeteries, are all in the Vasili Ostroff or island, a kind of suburb of St. Petersburgh, as Southwark is of London. Several circumstances render difficult the establishment of a permanent bridge; the great depth, the ice, and the dock-yard being above the only spot where the bridge could be built. A suspension-bridge has been proposed by Lieutenant-General Bazame, one of the ablest engineers in Europe. His design is truly magnificent, and certainly, if executed, would be one of the grandest monuments of the kind in the world. The property in the Vasili Ostroff would double in value, and the inhabitants of the capital in general, while they possessed the inestimable advantage of uninterrupted communication, would enjoy the proud spectacle of their country's history, traced in the bas-reliefs of metal on the towering supports of the chains, presenting a façade of 161 feet high.

then again swung round and definitively placed for the winter. The large space thus cleared remains uncovered for several weeks, freezing but very gradually from the edge of the ice which surrounds it: a proof that the current is too rapid to be frozen over in ordinary winters* if there were no ice brought down from the lake.

The temperature of the air is now sensibly colder, and in a short time, except in the part we have mentioned just below the bridge, or in any other equally large spot, if such there be, there is everywhere a thickness of ice sufficient for foot passengers, who are now seen crossing the frozen river in all directions. In a few days more the passage is judged practicable for carriages and sledges. Broad roads are then marked off by rows of fir branches stuck upright, and slopes of planks are constructed from the quays to the ice. The river now assumes the aspect of a flat-bottomed valley covered with snow; the carriages, sledges, merchandise, pedestrians, and troops passing and repassing in all directions, excluding the idea of the deep and rapid waters rolling beneath.

This state of things lasts generally about five months, as may be seen by the accompanying diagrammic table, *Plate* 1, in which the periods of freezing and clearing of the river for more than a hundred years past is laid down.

The table, it is presumed, will be easily understood. The vertical lines divide the years into months. The graduation on the two extreme verticals, and on one of the intermediate ones, indicate the years. At every tenth year a horizontal full line is drawn across, and at every fifth a dotted line. From left to right the table contains a period of sixteen months, that is to say, a whole year and part of the next, thus giving the complete circle of months in which are comprised the periods of the river's being frozen over and free from ice.

By following the horizontal line beginning at the year 1720, it will be seen, that the ice broke up in that year on the 11th of April, and that the river remained free till the 7th of November, when it was again covered with ice, and continued so till the 10th of April of the following year, still marked on the same horizontal line, bearing on the right the date of the year 1721. This latter indication is repeated on the left a line lower, where the 10th of April is again found. From it the eye runs along to the 20th of November, between which periods the river remained free in the year 1721, when it was again covered and continued frozen over till the 16th of April, 1722, and so on.

In some places it will be found that there are double indications, as about November from the years 1790 to 1795. They show that the ice, after being fixed, was again broken up, as we have already said happens occasionally.

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* The greater rapidity in this place, owing to the rush of water between the pontoons, no doubt delays still further the congelating process.

The bottom of the table shows when the river is invariably covered or uncovered, and the months in which its change of state occurs. The indications of the table may be thus resumed :—

Breaking up of the ice, and freezing of the Neva for the last 117 *years.*

Month.	Date.		Number of times.	
March	6	1	18	117
	From the 21 to 25 inclusive	4		
	26 to 31	13		
April	1 to 5	18	99	
	6 to 10	28		
	11 to 15	32		
	16 to 20	8		
	21 to 25	9		
	26 to 30	4		

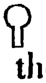
Freezing of the Neva.

Month.	Date.		Number of times.	
October	From the 16 to 20 inclusive	3	13	116
	21 to 25	2		
	26 to 31	8		
November	1 to 5	12	95	
	6 to 10	18		
	11 to 15	20		
	16 to 20	20		
	21 to 25	14		
	26 to 30	11		
December	1 to 5	3	8	
	6 to 10	3		
	11 to 12	1		
	14	1		

Hence we learn—*first,* that in the long period of 117 years the ice has never broken up before the 6th March, and only once at that early period ; 2ndly, that of 117 times, it has broken up 18 in March and 99 in April, and that the general period is from the 5th, to the 15th of April ; 3rdly, that it has only frozen once so late as the 14th December ; 4thly, that of 116 times, it has frozen 13 in October, 95 in November, and only 8 in December,—and that the general period is from the 5th to the 20th of November ; and, 5thly, that, one year with another, the navigation of the river may be said to be free for a period of seven months, and frozen over the remaining five.

Much has been said on change of climate, and there is little doubt but that the establishment of a considerable population in regions before uninhabited must produce local modifications of temperature. The draining of marshes, the felling of forests, and cultivation in general, increase the temperature; but where the atmospheric phenomena depend in a great measure upon relative position, perhaps even more than upon local influence, this latter will of course be less sensible. At most, local changes in the soil may modify the *degree* of heat and cold, of moisture and siccity, but can have little effect on the *periodicity* of the seasons. And thus, though the climate about the mouth of the Neva may have become milder since the foundation of St. Petersburgh, we have no proof of any change in the periodical return of the seasons or in their duration. Indeed, the table before us is a convincing proof of the contrary, the setting in and breaking up of the winter averaging the same time for the last century. The duration of the winter, we have said, is one cause of the great thickness of the ice at St. Petersburgh. I have seen it 3ft. 6in.; the drift-ice from the lake being on its arrival 2½ inches.

I was curious to observe the progressive increase as compared with the temperature of the atmosphere, in order to ascertain, if possible, the law according to which the congelation of running water is effected when its surface is already covered with ice. The temperature of the water at different depths, under the circumstance of the river being covered with ice, also appeared to me to be worthy of observation. Unfortunately, the thermometers I had directed to be made by the maker of greatest reputation here were so incorrect and carelessly graduated that I could place no reliance on them, and was therefore obliged to postpone my observations on the temperature of the water. Some time after I learnt that, at the Academy of Science, there was an excellent workman, a Mr. Girgenson, and I accordingly engaged him to make me the instruments I required. He could not, however, begin them immediately, having other work in hand. Other circumstances also prevented my beginning my observations on the progress of the congelation so soon as I could have wished. The ice became fixed this year (1833) on Monday the 20th of November (*old style*), and it was not till the 28th December, O.S.,* that I could begin.

I chose for my experiments a spot in the main branch of the river, at about 200 paces from the south bank, or near the middle of the stream, which in this place is 1260 feet broad. I here caused an opening to be made in the ice, which I found to be 1 foot 4·875 inches in thickness, and the depth of water from its surface in the hole to the bottom, 35 feet. The hole was made in this shape  ; the diameter of the round part three feet, and the breadth of the straight part one. Across the end of the latter

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* The Tables Nos. I. and II. are arranged according to the new style.

(thus) a plank, with its surface planed, and being 8 inches wide, 4 inches long, and 1 inch thick, was let into the ice, so as to have its upper surface level with that of the ice. This board, kept constantly clear, was to serve as the offset for my admeasurements, and effectually prevented all those errors that otherwise must have inevitably arisen from the addition at the surface of snow occasionally thawed and occasionally frozen into an icy mass. From the middle of another plank of the same dimensions rose perpendicularly a rod of hard wood, 1 inch square, 4 feet long, and graduated from the plank to the top into inches and eighths of an inch, having this figure . This gauge being let down into the hole lengthways was brought along the neck of the opening and close against the offset plank; it was then turned so as to have its own plank parallel to the offset plank, and perpendicular to the neck or straight part of the opening; it was then pulled up firmly against the lower surface of the ice, while the graduated part was kept in contact with the edge of the offset. The inches were now read off, and gave the thickness of ice between the two planks.

The accompanying table (No. 1.) shows the details of forty-one observations, the result of which are graphically represented, *Plate* 2. The table is of itself sufficiently intelligible, the plate perhaps requires explanation.

The numbers at the top are those of the observations, and serve equally for the three figures. The dates corresponding to these observations will be found on the table. Each *figure* has its separate scale marked on the verticals at the left; the first for the first figure, the second for the second, and the third for the third, as indicated at the top. In the *first figure* each vertical division represents 1° of Reaumur's thermometer, and is supposed to be divided into tenths. The mean temperature for the time elapsed between each observation (generally twenty-four hours, unless when accidentally interrupted, as seen by the table) is marked on the verticals corresponding to the number of the observation; and these points being joined exhibit the range or curve of the medium temperature of the atmosphere.

In the *second figure*, each vertical division represents 25° of Reaumur's scale. On the verticals are marked the successive additions of temperature, which being (with two exceptions only) always below *zero*, the curve connecting the several points show the daily additions and sum total of the *cold*.

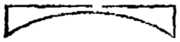
In the *third figure* the vertical divisions represent one inch, supposed divided into eighths. On the uprights are set off the thickness of the ice at each observation, and the curve formed by the junction of these points shows the daily increase and absolute thickness of the ice.

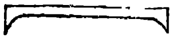
The object of my observations was to ascertain, if possible, the law of congelation of running water; and this law becomes evident by the simple inspection of the plate. The parallelism of the two lower curves, *figs.* 2 and 3, plainly prove that the thickness of the ice is exactly proportionate to the sum of the temperatures, or rather to the accumulation of the cold. The difference from absolute parallelism is so slight as evidently to be occasioned only by the snow with which the ice is occasionally covered, and which secures it against the immediate effect of the cold. On comparing the *third figure* with the *first*, we are not struck with any apparent correspondence, and yet such does exist as far as the nature of the case will allow. Thus, the whole range of the temperature in the *first figure* being *below* zero, the intermediate elevations of temperature can have no effect in *diminishing* the thickness of the ice. Its effects can, at most, be merely preventive of any increase of thickness. So do we find the horizontal parts of the *third figure* corresponding to the greater elevations of the first. Every individual rise in the *first figure* is not accompanied by a horizontal line in the *third*, for the very obvious reason that the temperature of the ice is much slower to change than that of the air; and the former, being considerably below zero, continues to freeze the water in contact with it below. The horizontality of the lower curve can only be effected when the increase of temperature of the air is very great or lasts long. If the increase of temperature be accompanied by a fall of snow, it will necessarily occasion a defect of correspondence between the curves of the *first* and *third figures*, as between those of the *second* and *third*.

What seems most remarkable is, the perfect parallelism of the two lower curves. We should naturally be led to imagine, at first, that a difference in the absolute thickness of the ice would modify considerably the *increase* of thickness for a given temperature. Thus if a given degree of cold, for twenty-four hours, increase the thickness of a mass of ice six inches thick by one inch, it is natural to imagine that the same temperature, for the same length of time, when the ice is twenty-four inches thick, would not increase it anything near an inch; and that, consequently, the *increase of thickness*, for regular increments of cold, would be in a diminishing ratio, determined by the successive thickness of the ice, so that the two curves, instead of being parallel, would converge. This, however, they do not, and the reason probably is, that in the same proportion as the ice thickens by continued cold it becomes itself colder, and thus a parity of action is maintained whatever be the thickness of the ice. If, after each addition of cold and consequent increase of thickness, the whole mass were to re-take the temperature of zero, then it is probable that equal degrees of cold, operating through masses of different thickness, would produce an increase, decreasing in proportion to the thickness the ice had already attained: this, however, is evidently not the case. Moreover, the water in contact with the lower surface of the ice, being at zero, cannot freeze at that temperature by reason of its motion: a still greater degree of cold is therefore necessary, whence it follows that, so long as the already formed ice remains at zero, no increase of thickness can take place; and this reasoning is confirmed by the inspection of the curves. Again, after the increasing temperature of the atmosphere has brought back the temperature of the ice to zero, any fresh increment of cold is, at first, but slowly followed by fresh congelation.

Upon the whole, then, it appears that in running water the process of congelation and thickness of the ice is strictly proportionate to the increments of cold, and that the positive increase of the ice (naturally modified in different rivers by the rapidity of their current) is for the Neva about 1 inch for every 25° of additional cold. The greater or less quantity of snow will further modify the result; but the same causes must ever produce the same effects when not interrupted by like disturbing circumstances. Hence there is, I think, little doubt but that the law, such as we have observed it, is constant; and if observations, similar to those here detailed, were made in rivers of different velocity, so as to arrive at a formula applicable to all cases, the thickness of the ice (the rapidity of the current being known) will give the sum of the temperature from the commencement of the congelation, from which the mean temperature is easily deduced—an object of considerable interest in countries where no meteorological observations can be followed—and, *vice versâ*, the sum of the temperature the thickness of the ice. It is likely that in still waters the same relation of thickness of the ice to the sum of the temperatures holds, but the positive thickness for a given number of degrees will be greater, still water freezing more readily than that which is in motion.

This law of congelation, though the more important, is not, however, the only result of the present experiments. In the course of them, other phenomena have been remarked, which perhaps are not altogether without interest.

1. The cake of ice generally formed on the surface of the water in the hole, being carefully detached from the sides and removed, was invariably found to be concave beneath, thus  that is, the round cake perfectly resembled an immense *plano-concave* lens, a form naturally resulting from the twofold direction of the frigorific action at the surface, and at the periphery of the hole. The concavity was observed to be greatest with a medium degree of cold, for when the cold was too intense, the action at the surface being more rapid than that from the sides,

the whole cake became thicker and the concavity proportionably less. When, on the other hand, the cold was but slight, the cake was thin and equally so everywhere, save quite close to the edge, where it suddenly turned off somewhat in this shape  The temperature at the surface, with the law of progressive congelation downwards being given, as also the inferior or ascertained graduated temperature of the ice of the periphery at different depths, the curve assumed by the lower surface of the cake might be ascertained, but it would be a problem more curious than useful.

The thickness of this cake, as specified in the last column of the table No. I., under the name of *ice formed in the hole*, is the mean between the thinnest and the thickest parts. The indications are in inches and tenths.

2dly. The next observation was a striking confirmation of a fact universally known, namely, the warmth maintained by a coating of snow. If snow fell immediately after the cake of ice had been removed from the hole and was drifted into the hollow (for the water was always a few inches below the surface of the ice of the river) so as to fill it, then, however intense the cold may have been in the 24 hours, not the slightest pellicle of ice was observable on the water on removing the snow.

3dly. The next observation I had occasion to make was that of the formation of a thick bed of snow below the ice and immediately contiguous to it.

In order to account for this, it must be observed that, when the surface of a river is frozen over, its current becomes assimilated to that of water flowing in a pipe, the resistance to its progress being increased by all the friction it experiences against the covering of ice. This friction, though its effect is felt through the whole mass of the vertical section, is sensibly greatest at the periphery of that section, and there, consequently, will the current be the most retarded. Now, if the water be at a very low temperature, though the motion may prevent its congealment into a solid mass, it may be inadequate to prevent a *particular mode* of congelation, which will differ from that observed in still water. Such was precisely the case in the present instance. The water in contact with the ice, and even for a few feet downwards, was found to be invariably at the freezing point, and the motion was sufficiently retarded to admit of its congealment into small flakes of two, three, or more, tenths of an inch in surface, which flakes were loosely agglomerated in a manner very similar to that we observe in the freezing of milk.

While this singular congelation remained under water it was invisible, being altogether transparent, but no sooner was it taken out of the water, than it appeared like snow of a dazzling whiteness, and from the self-same cause.

It is probable that the lower flakes were occasionally removed by the current, and others formed in their place, while the higher ones became less and less exposed as the mass increased in thickness downwards. As to these, indeed, not only they themselves must have remained motionless, but the water between them must have been stagnant. Now the whole mass being at the temperature of zero, it is matter of no small surprise that there could be any *fluid* particles whatever. Yet so it was, and the surface ice of the river increased in thickness infinitely slower (as may be seen by the table) than might have been expected from such a state of things. I see no other way of accounting for this than by supposing, that in order to the formation of *compact ice*, a certain arrangement of particles is necessary, and that the pre-existing arrangement in the flaky mass presents to the new arrangement obstacles which can be but slowly surmounted.

Indeed, the very smooth underside of the surface of the ice when taken up from the river, seems like a confirmation of this conjecture: for if the solid ice were merely formed by a successive conglomeration of the flakes below, then, upon removal of the ice, these would be found adhering to its surface pretty firmly and sticking up in all directions. But, as nothing of the kind is observable, we may suppose that, at whatever time the solid ice may be taken up, it is done at a moment when the operation of a new arrangement of particles is going on, and consequently when there is no adhesion between those already arranged and others in the act of being arranged; at a moment when, as it were, the magnetic axes of the molecules of the one mass, turning round those of the other, come into the perpendicular direction. But I shall no longer dwell upon this occult matter; it may be interesting to the physical inquirer, but seems to stretch beyond the limits of even the physical part of geographical science. Nor would I have dwelt so long upon the subject of this flaky formation, were it not that a similar one is formed (and from the same cause, *viz.* low temperature and a slow motion) at the *bottom* of the river. As well as I could ascertain by the sensation communicated to the hand by the lead-line, the mass at the bottom was not so thick as that at the surface, though it seemed more compact.

There is, I think, little doubt but that in as much as the temperature of the surface of the earth depends upon the temperature of the atmosphere, so that of the soil at the bottom of a river depends on the warmth or coldness of the water in contact with it. If the whole mass of water be at zero, so will the bed of the stream be at zero; and that such is the case in the Neva we shall presently see.

The friction at the bottom might be supposed somewhat greater than at the surface, the bottom having asperities which the surface ice has not; but be it observed, that as soon as a thin bed of the flaky congelation is formed, the friction, in as much as it depends on asperities, is the same at the bottom and at the top. The same causes therefore operating at the surface and at the bottom, the same effect of course results, and as at the top so at the bottom, there is a cake or bed of a flaky congelation: but that at the bottom, pressed by the superincumbent weight of the water, must be more compact, and, both by reason of this mechanical compression and a degree of cold less violent, is also less thick.* Of this snow at the bottom, a part, probably that in immediate contact with the bed, becomes gradually transformed into solid ice, which, if not thawed in the spring at the bottom itself, gets detached and rises to the surface.

This phenomenon is frequent in the Angara, and is not unknown even in the Thames. The circumstance is mentioned by Ireland, in his 'Picturesque Views on the River Thames,' and is corroborated by observations of Dr. Plott, who says, 'the watermen frequently meet the ice meers or cakes of ice *in their rise*, and sometimes in the under side inclosing stones and gravel brought up by them *ab imo*.' I shall not stop to examine the doctor's explanation of the phenomenon, but shall merely observe that the flakes of ice which rise from the bottom of the Angara often bring up in like manner large stones.

The freezing over of a river is by no means necessary to the formation of ice at the bottom. When the whole mass is cooled down to zero, it may, and most frequently does happen, that partial congelations are formed at the bottoms of rivers, while there is no ice at the surface, or merely at the edges. In the sea and in *deep* lakes this cannot happen, because in them the water at the bottom is found to be always *above* the freezing point. But to return to my experiments.

I had originally intended to observe the temperature of the river at different depths, at the same time that I ascertained the thickness of the ice, and expected to find the bottom two or three degrees above zero; and so it probably was for some time after the first fixing of the ice. Unfortunately, however, as I before mentioned, my instruments were not ready; and it was not till the 8th of March, new style, that is 96 days after the fixing of the ice, that I could begin.

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* A third cause for the lesser thickness of the flaky mass at the bottom, and which, it is probable, is even more influential than the very little difference of temperature, may be the lightness of the flakes, which as soon as detached by the motion of the water at the bottom, will rise. Nay, I think it likely that a great part of that which adheres to the under part of the surface ice may have been originally formed at the bottom, from which it has been detached by degrees and risen by its lightness.

The result of 21 observations is given in Table II.; but in order to show what degree of confidence these observations may claim, I shall describe the instrument employed upon the occasion and which I found to answer perfectly. Indeed I may recommend it with confidence to such as may be inclined to make similar experiments.

The object was to have a thermometer which would indicate *exactly* the temperature of the water at the parts where it should be placed, and not alter its indications in passing through strata of different temperatures.

The maximum and minimum thermometer of Six would answer this purpose perfectly, were not the indices liable to be deranged in the motion of pulling up the instrument. Its horizontal position could be easily maintained, but the liability to derangement, thus mentioned, absolutely precludes its use.

The bathometer then occurred to me and I tried it; but soon found that no dependence could be placed on it, both in consequence of the strength of the current which carried it in a slanting direction, and the difficulty of getting it drawn up with that equable and steady motion indispensable to prevent the opening of the valves and consequent admission of water of a different temperature: moreover, in going down it met with the flaky congelations of which I have spoken, a part of which fixing in the valves, prevented their closing, and thus rendered inapplicable, in this case, an instrument sometimes employed with success.

I then caused a thermometer to be made with a cylindrical bulb, eleven lines in length and three in diameter, with a tube of very small bore. This instrument marked with great exactitude the smallest change of temperature. Its range was from — 8° to + 40 of Reaumur's division. The degrees were 15 hundredths of an inch in length, and subdivided into five parts, each of which being ·03 of an inch, allowed me to observe very exactly the half of one of them, or the tenth of a degree, and, with sufficient accuracy, even the hundredths.

This thermometer was now fixed into a cylindrical box of brass one-tenth of an inch thick of metal. The box was four inches high and four in diameter, and the thermometer so placed in it as that the bulb (which had no contact with the metal of the scale) was exactly in the centre. A tube of clear white glass, about one-tenth of an inch thick and an inch and a half in diameter, with a brass virol at one end, was now passed over the exposed part of the thermometer and screwed down air-tight to the top of the cylindrical box. The upper part of this glass tube was also furnished with a virol, into which was screwed a brass cap with a ring to lift up the whole instrument by. This cap had a hole with a cork in order to let in water, and three branches extending to a circumference equal to that of the cylinder at bottom.

In the under part of the cylindrical box was an opening about eight-tenths of an inch in diameter, closed by a plate which screwed into it. By this opening were successively introduced different bad conducting substances, and the sensibility of the instrument was tried with the box filled with air, with water, with eider-down, with charcoal in powder, and with tallow, poured in hot and allowed to cool.

It would be too long and needless in this place to detail all the observations that were made with these five substances: let it suffice, that with the last, *i. e.* the tallow, the instrument required above 11 hours to sink from a temperature of + 14° to zero; and that, being at zero and removed into a temperature of + 18°, it required three minutes to rise the first tenth of a degree.

Now, presuming beforehand that the difference of temperature between the bottom of the river and the surface might be about three degrees, the same change of one-tenth would not be effected in less than 20 minutes, whereas, the whole time employed in raising the instrument from the bottom of the river to the surface (a depth of 35 feet) would scarcely exceed half a minute.

In order still more to prevent the possibility of error, the glass tube in which the visible part of the thermometer was contained was filled with water and hermetically stopped up by the cork; and thus the portion of the column of mercury, which in the tube rose above the brass box, (and which was about an inch in length,) was secured by a thickness of half an inch of water, and one-tenth of an inch of glass, independent of the thickness of the thermometer tube, from the immediate impression of the surrounding medium.

Upon the instrument thus arranged I thought I could rely with perfect confidence; but as an excess of precaution is never a fault in such cases, the whole instrument was put into a cylinder of tin, into which the brass box exactly fitted at the bottom, while the branches at the top kept the whole steady. This tin case was filled with water, and closed so perfectly as to let little or no water escape. The top or lid was a cap with hitches, and was fixed on much in the same way that a bayonet is fixed to a musket.

Round the tin case were rings of iron strongly soldered, two on each side, one near the top and the other near the bottom. A rope was passed down the two on one side, then under the bottom and up the two of the other side and fastened. Thus the whole was slung like the leathern case of a portable telescope. Two other and similar rings were also soldered to the outside of the tin case to receive another and a thicker rope. At the lower end of this thick rope was fastened a weight of 80lbs., which being let down to the bottom remained there; the upper end of the rope, after being passed through the rings of the tin case made to receive it, was fastened to a bar of the inclosure raised on the ice. This weight, with the exception of the two or three first days, remained down during the whole time of the observation, and the rope being stretched was as perpendicular as the rapidity of the current would permit. By this arrangement the thermometer case traversed freely along the fixed rope, and the instrument could be lowered, or raised, or fixed at any depth, with the greatest ease.

There was but one inconvenience, which was the length of time required to leave the instrument in the water, if, on letting it down, its indication was high: but by hiding the ends of the ropes beneath the snow, there was little probability of the instrument being stolen, though hundreds of persons were daily crossing the ice close to it. The indications of the table will show that, fifteen times out of twenty-one, the instrument remained down twenty-four hours and upwards, consequently a much longer time than was strictly necessary.

Before pulling up the instrument, the temperature of the water at the surface was taken, as also that of the air; the instrument was then immediately drawn up, the tin case suddenly opened, and, the brass cylindrical box being still in part immersed in the water of the case, the indication of the thermometer was read off and registered*. It was then let down again, to remain till the next day.

From the Table, it will be observed that there is something like a relation of the temperature of the water to that of the air, the former following the latter after twenty-four hours. The variations are however too trifling, I think, and the number of observations too few, to enable us to conclude anything positive in this respect. The general result is to be taken from the means, and these show that, when the surface of the water has been for some time covered with ice, the temperature of the water in contact with the ice, or at the surface, and for several feet below it, is at the freezing point, or zero; and that, with the single variation of about 0·014 of a degree, at the depth of 21 feet, (which anomaly may, from its minuteness, be an error of observation due to the effect of parallax,) the heat increases downwards until close at the bottom, where it again seems to retrograde. This decrease of temperature at the immediate bottom is evidently owing to the diminished velocity, which favours the formation of the flaky congelation at the bottom, of which we have already said so much.

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* The three thermometers were rendered perfectly comparable by tables of corrections for their slight differences with a standard thermometer.

The difference, however, of the coldest and the warmest part does not amount to 0·06 of a degree, a quantity absolutely insignificant in an experiment of this kind.* During the last observations the weather was getting warmer, and the temperature of the water accordingly oscillated rather above than below the temperature of some of the intermediate observations.

I regret that I was prevented by the circumstances already related from beginning my observations on the temperature of the water sooner, and consequently making a greater number. The twenty-one, however, that have been made suffice to prove, that after the Neva has been for some time covered with ice, the whole mass of water flowing beneath is at zero; for I repeat, the few hundredths above that may be neglected.

When the thaw set in, I was obliged to discontinue my experiments. This occurred on the 31st of March (N. S.), and I caused at the same time a large block of ice to be taken up from the place—on measuring the thickness of which, I found it to be 32 inches. Thirty inches may, I think, therefore be taken as the average thickness which the ice attained this winter (1833-4).

The thickness was not alike in all places. Thus, on the 1st of February, when at the place of my observations it was $27\frac{1}{8}$ inches, a hundred paces farther on it was only 16 inches, at another 15, and at a third $22\frac{1}{2}$. But it must be remembered, that the first ice which settles is that which comes from the lake, and this is not only of different thicknesses, but in many places the broken cakes are pushed one over the other, so as to double or treble their thickness, while the spaces between are not frozen, properly speaking, till some days after. The 32 inches, therefore, above mentioned, are not to be regarded as produced *solely* by the cold at St. Petersburgh; I think that 6 inches may be very fairly deducted, leaving 26 inches for the maximum, which thickness the ice would certainly never attain, if the river were not in the first instance covered with that which comes from the lake. Upon the whole, it must be confessed, that though we are at first struck with the great thickness of the ice, yet when we come to examine the subject, we find the progress of congelation rather slow than otherwise; for the very favourable circumstances of an immediate covering in the first instance, and afterwards a constant medium temperature of —3°·5 for 120 days, produce only an average daily increase of two lines.

When to facts such as these we compare the statements of authors who have spoken of severe winters, we confess, that in our utter inability to explain the prodigious effects of which they speak, we are unwillingly reduced to the painful alternative of doubting the correctness of the statements. Thus we find in a work by M. Mann, entitled 'Mémoires sur les Grandes Gelées,' page 45, that, "in the year 763, four months' cold, from the beginning of October to the beginning of February, froze the Black Sea to a distance of 100,000 paces from the coast; and that the ice was 30 cubits thick, and covered with a bed of snow of 20 cubits, the whole forming a solid crust 50 cubits thick!" For this fact M. Mann quotes the Byzantine authors, and, after them, Briet, Lenglet du Fresnoy, &c. He also states, that in the winter of 1363-4 the Rhone was said to have been frozen to the depth of 15 feet; and that, in 1709, the Meuse, at Namur, was frozen 5 feet, the cold lasting ten weeks. Now considering the climates of the Black Sea, and the southern latitudes of the Rhone and of Namur, as compared with the latitude of St. Petersburgh, cold, sufficient to have produced effects such as are here stated, must have been intense beyond conception.

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* It is probable the difference would be considerably greater if the water were deeper; as it is, it coincides with the observations made in the Polar Seas, where the water is *warmer* as you descend.

I should perhaps now conclude these observations, which have been insensibly lengthened beyond what I originally intended, but I cannot possibly refrain from saying a word on a phenomenon as beautiful in its effect as interesting in its progress.

The last ice which comes down from the Ladoga, on the breaking up of the river, is invariably composed of vertical needles, so slightly agglomerated as to be separated on the least percussion. I at first concluded this to be ice formed in some particular situation, either above some soil emitting gas in abundance, or perhaps among the eddies and falls of Imatra, whence it was brought into the lake by the current of the Voxa, and finally passed into the Neva. Attentive research, however, has convinced me that it is nothing more than a natural and spontaneous process of disaggregation, which goes on alike in the river as in the lake, in ice still floating and in ice broken up.

Having observed some loose pieces of ice lying about, formed into needles like that which comes down from the lake, and knowing that these pieces were from the immediate neighbourhood of the place where they lay, I went to a spot where several men were employed cutting blocks for the summer provision of the inhabitants. These blocks, which are generally about four feet six inches or five feet long, and from two and a half to three feet broad, with a thickness of two feet, more or less, are placed endways in rows, to be forthwith taken away on sledges to different parts of the town. Upon examining these blocks, I found in them all, more or less, rows of very minute air-bubbles extending in straight lines, sometimes a little inflected, from the *upper surface* of the ice towards the lower, within from two to five inches of which they terminate. Other blocks presented these bubbles united, so as to form cylindrical canals, a little thicker than a horse-hair. Observing still further, I found blocks in which the process was more advanced, and two, three, or more clefts struck off in different directions from the vertical veins, so that a section perpendicular to the vein would represent in miniature the star-formed cracks of timber. Finally, in some pieces, these clefts united from top to bottom of the veins, separating the whole mass into vertical prisms, having a greater or less number of sides. In this state a slight shock was sufficient to detach them; and the block, with its scattered fragments, was in all respects the exact miniature resemblance, in crystal, of a Giants' Causeway. The surface was like a tessellated pavement, and the columns rose close, adhering and parallel, from the compact mass of a few inches at the under surface. More or less time is required for the process; which I have since seen in all its different stages. I have observed some in which the prisms (which are of all dimensions, from a few lines thick in some blocks, to an inch and upwards in others) are in curvilinear concretions, like certain species of actinolite. The prisms sometimes run one into the other, but are never articulated or fractured in a direction perpendicular to their axes. On the contrary, they even seem difficultly frangible in that direction, and when broken have a conchoidal fracture. They are moreover sonorous, consequently elastic, and consequently combined with a portion of caloric.*

This tendency to columnar disintegration seems inherent in the nature of the ice, and altogether independent of its position in or out of the water. Towards the latter part of the season, when the snow, in consequence of winds and thaws, has in a great degree disappeared from the surface, the ice on the river presents, in many places, a very remarkable appearance. The surface ice, clear and polished, is traversed in different directions by veins, sometimes meeting, though never crossing, and generally parallel to each other. The veins exactly resemble the veins of quartz which traverse gneiss, trap-rocks, &c. They vary in thickness from one to four and five inches, and exhibit regular and parallel fissures perpendicular to the direction of the veins. These veins, which vary in length from two to three or four feet, are nothing more than the sections of the flakes of ice turned on end on the first setting of the river. These flakes, which at first stick up irregularly in all directions above the surface of the water, get worn down by the elements during the winter to the level of the surface ice of the river, and in this state, though jammed in and forming a continuous mass with the surrounding ice, they undergo the same process of prismatic or columnar disintegration as that of the great blocks already mentioned; with this difference only, that in the veins the columns invariably reach from the one to the other surface.

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* Caloric seems to be the principle of all elasticity. That ice contains a notable portion of caloric has, however, been satisfactorily ascertained by many direct experiments.

It seems evident from this, that the process is entirely independent of air or gas rising from the water, and is probably owing to the arrangement of the particles of water in the process of congelation, and the subsequent changes induced by time and variation of temperature. This, however, is a mere conjecture; but considering how little the process of congelation is as yet understood, every observation on the subject of ice may be worthy the attention of the inquirer.*

Every traveller who has seen ice in large masses speaks with rapture of its colours. To some it is of a roseate hue; to others, emerald green; some describe it as being blue; others, as sea-green. I have examined the blocks on the Neva, in all directions, under all aspects of the sky, and at different times of the day, and have found the colour to be invariably the same when the ice is pure. It is then of a pale blue, inclining to aqua-marine green; if there be snow on one side, the blue is less visible, and the colour is sensibly greener. Examined closely, the blocks present innumerable cracks near the surface, which, like similar accidents in rock-crystal, refract the light into all the colours of the prism; the most predominant, however, is a rich and exquisitely beautiful sapphire blue, which, being softened by the distance, is probably the cause of the pale blue tint of the whole.

Were I to describe all the various and graceful or singular forms of congelation which may be here observed, there would be no end to this paper, already, I fear, too long. I shall, therefore, conclude by expressing my regret at not having been able to extend my observations further, and hoping that, such as they are, they may be found acceptable to those who study the physical part of geography.

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* Scoresby, speaking of the icebergs of Spitzbergen, says, "They are full of rents, as high as any of our people ascended them, extending in a direction perpendicularly downwards, and dividing them into innumerable columns. The surface was very uneven, being furrowed and cracked all over.'

TABLE showing the Progress of Congelation of the Neva at St. Petersburgh, in the Winter of 1833-34.

Number of Observations.	Date. D.	Date. Hour.	Positive thickness of the ice. Inch	Daily increase of thickness. Inch.	Increase of thickness since the first day. Inch	Mean temperature for the time elapsed between each of the observations. Deg. R.T.	Difference of the mean temperatures. Dg. R.T.	Sum of the temperatures since the first day. Deg. R.T.	Thickness of *ice formed in the hole* from one observation to another. In.	REMARKS.
	January.					°	°	°		
	9	2½ p.m.	16 7/8	..	..	..	..	..	..	Starting point.
1	10	1½ p.m.	17 7/8	1	1	−14,5	+1,0	− 14,5		
2	11	noon	18 4/8	5/8	1 5/8	−14,5	0,0	− 29,0		
3	12	noon	19	4/8	2 1/8	−14,5	0,0	− 43,5	2,5	
4	14	noon	20 2/8	1 2/8	3 3/8	−16,7	−2,2	− 60,2	5	Result of 48 hours.
5	15	½ p.m.	21 2/8	1	4 3/8	−17,3	−0,6	− 77,5	2,8	
6	16	noon	21 5/8	3/8	4 6/8	− 8,6	+8,7	− 86,1	..	Snow having fallen, the hole remained covered within, and was therefore prevented from freezing.
7	17	½ p.m.	22	3/8	5 1/8	−13,8	−5,2	− 99,9	3	
8	18	noon	22 3/8	3/8	5 4/8	−12,1	+1,7	−112,0	1,1	Snow lying everywhere six inches thick.
9	19	½ p.m.	22 7/8	4/8	6	− 8,6	+3,5	−120,6	1,2	
10	20	noon	23	1/8	6 1/8	− 0,6	+8,0	−121,2	..	No ice in the hole, it being a thaw.
11	21	noon	23	..	..	+ 0,2	+0,8	−121,0	..	Idem.
12	22	½ p.m.	23	..	..	− 4,8	−5,0	−125,8	1,3	More snow had fallen, but not till after the surface ice had been formed.
13	23	noon	23 1/8	1/8	6 2/8	− 6,2	−1,4	−132,0	..	Orifice filled with snow; no surf. ice.
14	24	½ p.m.	23 2/8	1/8	6 3/8	− 9,2	−3,0	−141,2	..	Idem.
15	26	½ p.m.	24	6/8	7 1/8	−15,3	−6,1	−156,5	3	Result of 48 hours. The three inches of surface ice here indicated was rather compressed snow than real ice; it was opaque and dingy.
16	27	noon	24 5/8	5/8	7 6/8	−18,5	−3,2	−175,0	3	The cake of ice of the orifice covered with beautiful foliated concretions of snow; the thick transparent ice round the hole exhibiting fine air-tubes, finer than a hair, and converging from the periphery towards the centre; cracks, occasioned by percussion, refracting the most beautiful sapphire-blue, and innumerable irises, like those of quartz.
17	28	noon	25 2/8	5/8	8 3/8	−19,3	−0,8	−194,3	3,2	
18	29	noon	26	6/8	9 1/8	−12,3	+7,0	−206,6	2	
19	30	noon	26 4/8	4/8	9 5/8	− 9,6	+2,7	−216,2	0,9	Surface in general covered with seven inches of snow.
20	31	noon	26 6/8	2/8	9 7/8	−12,4	−2,8	−228,6	2,6	
	February.									
21	1	noon	27 1/8	3/8	10 2/8	−15,6	−3,2	−244,2	2,9	
22	2	noon	27 4/8	3/8	10 5/8	−11,9	+3,7	−256,1	2	
23	5	½ p.m.	28 4/8	1	11 5/8	− 8,8	+3,1	−264,9	1,7	Result of 72 hours.
24	6	½ p.m.	28 7/8	3/8	12	−15,7	−6,9	−280,6	2,5	
25	7	noon	29 2/8	3/8	12 3/8	− 6,8	+8,9	−287,4	1,6	
26	8	noon	29 4/8	2/8	12 5/8	−10,8	−4,0	−298,2	3,2	One-half of the thickness of the ice in the hole transparent, the other opaque.
27	9	noon	29 5/8	1/8	12 6/8	−10,2	+0,6	−308,4	2,7	
28	10	½ p.m.	30	3/8	13 1/8	− 6,3	+3,9	−314,7	0,5	Much snow had fallen during the last 24 hours.
29	11	1 p.m.	30 1/8	1/8	13 2/8	− 6,4	−0,1	−321,1	1,1	Snow lying a foot deep everywhere.
30	12	½ p.m.	30 3/8	1/8	13 3/8	− 9,4	−3,0	−330,5	1,8	
31	13	½ p.m.	30 6/8	3/8	13 6/8	−11,1	−1,7	−341,6	2	
32	14	½ p.m.	31	2/8	14	−13,6	−2,5	−355,2	2,7	
33	16	noon	31 5/8	5/8	14 5/8	−12,4	+1,2	−369,6	4	Result of 48 hours.
34	17	noon	31 5/8	..	..	− 3,0	+9,4	−370,0	..	Orifice filled with snow, and no ice formed.
35	18	noon	32 3/8	6/8	15 3/8	− 0,6	+2,4	−370,6	..	No ice nor snow in the orifice, it being a thaw.
36	27	½ p.m.	32 4/8	1/8	15 4/8	− 1,4	−0,8	−372,0	2	Of the nine preceding days, eight were a great thaw, which rendered it impossible to pass on the ice for the melted snow, but with inconvenience. The two-tenths of ice in the hole, as also the one-eighth increase of the main ice, entirely due to the cold of the last 24 hours.
37	28	noon	32 4/8	..	..	+ 0,8	+2,2	−371,2	3	
	March.									
38	1	noon	32 5/8	1/8	15 5/8	− 2,6	−3,4	−373,8	1,4	
39	2	noon	32 5/8	..	..	− 3,3	−0,7	−377,1	1,7	
40	3	noon	32 5/8	..	..	− 1,5	+1,8	−378,6	1,2	
41	4	2 p.m.	32 5/8	..	..	− 5,6	−4,1	−384,2	2,3*	

* The indications of this column are in inches and tenths of an inch.

TABLE showing the Temperature of the Neva at different Depths, the River being Frozen Over.

Number of Observations.	Depth.	Date of Observation. Instrument, Month of March, 1834.				Instrument remained down.	Thermometer, No. 212.		Therm. No. 202.	Therm. No. 206	Mean atmospheric temperature of the 24 hours preceding the taking up of the instrument, as observed at the Academy of Sciences, a few paces from the place of observation.	Time employed in drawing up the instrument.	REMARKS
		Let down		Taken up			Indication at the moment of letting down.	Indication when drawn up, or temperature of the water at the given depth.	Temperature at the surface.	Temperature of the air at the moment of taking up the instrument from the bottom.			
	Feet.	Day.	Hour.	Day.	Hour.	Hours.	Deg. R. T.	Deg R. T	Deg. R T.	Deg R. T.	Deg. R. T.	Seconds.	
1	34	8	7 a.m.	—	5 p.m.	10	+ 0·12	+ 0·12	Zero	+ 1·12	+ 1·3	45	This depth is that of the bottom of the river, *minus* 1 foot the height of the suspended weight preventing the instrument from touching the soil.
2	idem	9	6 a.m.	—	5 p.m.	11	+ 0·12	+ 0·12	id.	+ 1·31	+ 0·2	30	
3	idem	10	6¾ a.m.	—	5 p.m.	10¼	+10·58	+ 0·07	id.	− 4·37	− 2·9	30	
4	idem	10	5 p.m.	11	5½ p.m.	24½	+ 0 07	+ 0·02	id	− 5·65	− 5·9	26	
5	18	12	7 a.m.	—	5½ p.m.	10½	+ 8·44	+ 0·02	id.	− 5·26	− 7·5	19	
6	28	13	7 a.m.	—	5¼ p.m.	10¼	+ 4·39	+ 0·02	id.	− 3·20	− 6·5	20	
7	14	13	5¼ p.m.	14	5 p.m.	23¾	+ 0·02	Zero	id.	− 0·35	− 3 7	10	
8	7	15	½ p.m.	16	4½ p.m.	16	+ 4·28	Zero	id.	− 0·22	− 1·7	3	
9	34	17	4½ a.m.	18	4 p.m.	23½	+ 9·28	+ 0·02	id.	− 4·30	− 5·1	30	Temperature of 48 hours.
10	28	18	4 p.m.	19	4½ p.m.	24½	+ 0·02	+ 0 07	id.	+ 0·33	− 3·4	12	Idem.
11	21	19	4½ p.m.	20	4½ p.m.	24	+ 0·07	+ 0 04	id.	+ 0·51	− 1·2	10	
12	14	20	4½ p.m.	21	4½ p.m.	24	+ 0·04	+ 0·04	id.	− 1·33	− 2 2	6	
13	7	21	4½ p.m.	22	5 p m.	24½	+ 0·04	Zero	id.	− 2·70	− 3·6	3	
14	28	22	5 p.m.	23	4½ p.m.	23½	Zero	+ 0·07	id	− 3·20	− 4 4	14	
15	14	23	4½ p.m.	24	5 p m.	24½	+ 0·07	+ 0·02	id.	− 1·33	− 3 5	7	
16	28	24	5 p.m.	25	5 p.m.	24	+ 0·02	+ 0·07	id.	− 1·53	− 3 5	15	
17	14	25	5 p.m.	26	5¼ p.m.	24¼	+ 0·07	+ 0.02	id.	− 1 00	− 4·1	8	
18	34	27	4½ p.m.	28	4½ p m.	24	+10·27	+ 0 08	id.	− 2·31	− 3·8	25	The rope being frayed, obliged to take up the instrument.
19	18	28	4½ p.m.	29	5 p m.	24½	+ 0·08	+ 0·08	id	+ 1·12	− 2 7	15	Temperature of 48 hours.
20	21	29	5 p.m.	30	4½ p.m.	23½	+ 0·08	+ 0·01	+ 0·02	+ 4·11	+ 3·4	16	
21.	28	30	4½ p.m.	31	½ p.m.	20¼	+ 0·04	+ 0.06	Zero	+ 3·42	+ 1·7	20	

Recapitulation . . . .

Depth.	No. of Observations	Medium Temperature
Surface	21	0·00
At 7 feet . . .	2	0·00
At 14 id. . . .	4	+ 0·02
At 18 id. . . .	2	+ 0·05
At 21 id. . . .	2	+ 0·04
At 28 id. . .	5	+ 0·053
At 34 id bottom	6	+ 0·055

II.—*Remarks on the Heavy Swell along some of the West-India Islands, commonly called " Ground" or " North Sea;" and on the Set and Velocity of the Tides, and the Effects produced by their transporting power, among the Virgin Islands.* Communicated by Robert H. Schomburgck, C. M. R. G. S. of London. Read 26th January, 1835.

THE influx of the tide from the sea, near the mouths of large rivers, counteracts their current, and by forcing back their waters occasions a swell which has been called the bore or mascaret. Where the river near the mouth is almost level with the sea, the collision of the contending waters is sometimes tremendous, and causes a wave of twelve or fifteen feet in height. The Ganges, according to Major Rennell, but more so the rivers on the north-eastern coast of South America, have this bore; and Romme observes, " that during three days at the equinoxes, there is a considerable swell at the mouth of the Amazon, which causes such a noise, that it may be heard at the distance of two leagues;"* and in the Tumry channel, river Aourary, the sea rises forty feet in less than five minutes, this constituting the whole rise of the tide, as the ebb immediately takes place and runs with great velocity.

Of quite a different nature, but equally dangerous in its effects, is the heavy swell that may be observed occasionally along the northern coasts of some of the West India Islands; and which has been called by the inhabitants the " Ground," or, in Jamaica, the " North Sea." This rises, rages, and subsides, when the air is calm, when there has been no indication whatever of a previous gale, or even when light airs have for a considerable period preceding come from the southward of east. The waves approach in gentle undulations, but suddenly swell against the shore and break with the greatest impetuosity. The rise takes place sometimes gradually, but more frequently quite unexpectedly, the waves reaching an uncommon height.

A heavy ground sea is distinguished by something grand and sublime. The sea approaches in undulating masses, which suddenly rise to large ridges, crested with foam, and form billows that burst upon the beach with the greatest impetuosity; the spray flying, where the waves dash against cliffs, often more than a hundred feet high, attended with loud roarings resembling thunder, which subside into a rumbling noise, caused by the nodules and fragments of rock with which the breaker was charged when advancing, which on its retreat roll backwards and are again driven forward by the next surge. Wave then follows upon wave in quick succession, there being only apparently a short interval after the third. The sea for many miles from shore assumes a peculiar aspect, different tints of blue, from the lightest to the darkest, forming a strong contrast with the snowy foam of the breaking waves, when they strike against a hidden rock, or with the white line visible along the whole coast. The eastern Bahamas, the north-eastern coast of Jamaica and St. Domingo, but chiefly Puerto Rico and the Virgin Islands, and in a less degree the northern Caribbee Islands, are subjected to this ground-sea.

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* It has been poetically said, that the Genius of the river and the God of the ocean contend for the empire of the waters.

The operating cause of this sudden rise of the sea along shore at these places not being visible, and the air being generally calm when it takes place, the inhabitants have ascribed it to submarine earthquakes, the influence of the moon, and many other phenomena. It may be, however, considered as a rule, that whenever the wind gets to the northward of east for a day or two, there will be a ground-sea at the northern side of the islands; and I have formed, therefore, the opinion, that it is caused by gales in the Atlantic, or on the northern coasts of America. The friction of the wind upon the surface of the water causes little elevations or ridges, which by continuance of the force gradually increases, chiefly when the wind sweeps over a great extent of water. Finding no resistance and having sufficient depth to sink directly down, they proceed with the direction of the wind and remain natural waves, until they meet repercussion from dashing against the shore. when they rise to an elevation much above their natural state. The period when the ground-sea sets in is generally October, and it continues, though with some intermission, till April and May. Any individual acquainted with the coasts of North America, will be aware that during that time frequent storms prevail, and the circumstance that a northern wind either precedes, sets in with, or follows a ground-sea, and that only the northern sides of the islands are exposed to it, confirms me in my opinion. A glance on a chart of the Atlantic Ocean, proves that Puerto Rico and the Virgin Islands oppose the first resistance to the waves caused by a northern storm on the North American coast, or in the Atlantic, from the fortieth to the sixtieth meridian. The wind accompanying or preceding a ground-sea is generally from the east of north; the waves are, therefore, propelled more or less in a western as well as southern direction, and the Bahamas and even Bermuda may escape, whilst the islands from Barbados to Puerto Rico, but more particularly the latter and the Virgin Islands, receive its first impulse.

One might conclude, it is true, on first consideration, that Jamaica, in consequence of its sheltered situation, would be exempt from a ground-sea thus originating; but its north-eastern coast is exposed to the main ocean, though at a distance of 150 leagues from it; and a body of water, driven by means of the prevailing wind through the passage, would be so affected by the gradually diminishing channel and the projecting head-land of Cape Maize and Cape St. Nicholas, as to increase in velocity, and thus finally break on the north-eastern coast of Jamaica, with more violence than its sheltered situation would lead us to suppose. I must certainly confess, that my opinion has been objected to by many of the inhabitants of the Virgin Islands, who rather attribute the phenomenon to causes arising in the bottom of the sea; in which they consider themselves justified by the extent to which a heavy ground-sea breaks up the bottom—the sea, to a considerable distance from the shore, becoming discoloured—and even anchors being removed from their holding-place, and vessels being driven amongst the breakers and dashed to pieces. But the discolouration of sea, to a greater or less distance from the shore, according to depth, is effected likewise during heavy gales, and is due to the action of the waves. The depth to which the moving action of waves extends has not been properly estimated, in consequence of the difficulty connected with such an estimate, the power of the waves continually varying. Some have considered ninety feet, or fifteen fathoms, the limit to which this disturbing power extends; but this requires confirmation. In the present case, however, the depth near shore is seldom more than from four to fifteen fathoms—in many places shoaling to a few feet—and thus the action of the waves caused by a ground-sea must become apparent; and the moving power of the waves on the bottom will tend to turn up anchors chiefly when the wind unites its powers above with the turbulent character of the sea below. My opponents in opinion have further adduced, that there are likewise northern gales during the summer months in the Atlantic: but these islands are also occasionally visited by ground-sea during June, July, and August. We may call a ground-sea a temporary current, caused by a severe gale, of longer or shorter duration; and every navigator knows from experience how common these currents are, and that they are more particularly felt along coasts and through channels. Major Rennell, in his 'Remarks on the Channel,' observes,—"It is well known how easily a current may be induced by the action of the wind, and how a strong south-west or north-west, and even a north-east wind, on our own coasts, raises the tide to an extraordinary height in the English Channel, the river Thames, the east coast of Great Britain, &c., as these winds respectively prevail." Mr. Boyle proved, by numerous experiments, that the most violent wind never penetrates deeper than six feet into the water; and, consequently, it can only be elevated six feet from the level of the surface where there is no impediment, and where several waves are not heaped together by a violent tempest: the utmost elevation of a natural wave is therefore twelve feet. It has been objected, that if the ground-sea originated with gales in the Atlantic, the whole surface between these islands and the scene where the gale took place would be agitated; and I agree with them, but surely it cannot be supposed that there should be accidental or compound waves the whole distance. We have seen that a natural wave, according to Boyle, can only be elevated twelve feet in deep seas; according to others, twenty feet: and as the originating cause ceased with the gale, and the undulations are afterwards only propelled by previous waves, they must lose in height, and become, at a great distance from the spot of the gale, and where the wind does not sweep over a great extent of water, less perceptible than on coasts where impediments are thrown in their way. The northern wind acts, however, still upon them, and prevents their altogether subsiding; and in consequence of the earth's rotation, they receive a more or less western direction: arriving, therefore, at this archipelago, they find their way obstructed by reefs and shores, are acted upon by repercussion, and by the dashing of several waves together that loud noise is caused which accompanies the heavy swell or ground-sea; and which I have known to continue for a week or two when a northerly wind was at the same time prevailing. A southern gale will likewise produce a heavy swell on the southern side of these islands; and during the gale of the 30th and 31st of August, 1833, this was felt with great violence on the southern shore. But, generally speaking, neither in force nor duration are these surges to be compared with those of the northern side; the group of the Virgin Islands being protected in this direction by the Caribbean Islands or by the Columbian coasts, and not exposed to the swell of the main ocean.

I observed previously, that the Virgin Islands and the northern shore of Porto-Rico are most exposed to a ground-sea; and, indeed, the diversity in the line of the northern coasts along these islands, and their present aspect, prove evidently the strength and battering power of the waves. The seaward front of the small islands Camanoes, Guana Island, Jost Van Dyke's, Tobago, Loango, Green Island, and Thatch Kay, as well as the shore at Tortola from Josiah's Bay to Cane-Garden Bay, and the whole northern shore of St. Thomas, consists of perpendicular cliffs of mostly unstratified rocks, presenting a front in which the force of the waves has formed cavities, chiefly where the broken wave was driven by local circumstances more in one direction than in another. I have observed several instances where the water, after having finished the vault, has worked its way upwards through the rock until the compressed air found an egress. The noise which is caused by the blast of the compressed air, held between each wave as it rolls into the cave, is considerable, and when heard at a great distance may be compared to the discharge of heavy artillery.

The situations mentioned previously offer scarcely any beach, or, where this is the case, they have been defended by coral reefs, which break the greatest force of the approaching wave, and prevent it from making inroads upon the land; nevertheless, a heavy ground-sea will tear up large pieces of coral and throw them on the beach. It would appear that nature has provided defences wherever the land becomes less precipitous, and protecting cliffs are not opposed to the battering power of the waves, which otherwise would become a continued and powerful agent of destruction. All the bays along the northern shores of Tortola, St. John's, and St. Thomas's, which, through their situation, are exposed to a ground-sea, are thus more or less protected by coral reefs.

Partial shingle beaches are to be met with at the extreme ends of the bays, where they bound on cliffs, and prove the effect which the breakers have had on the solid gneiss-rock. Ballast Bay offers almost the only example of an entire shingle beach on the northern side; and its position fits it to receive the nodules brought down by the mountain torrents or torn up from the opposite cliffs at Richmond Hill, which consequently appear among the specimens of rock composing this beach*.

In consequence of the ground-sea, weeks sometimes elapse before a boat is able to land in some bays on the northern side of Tortola; and planters frequently find it most difficult to ship their produce.

The cultivation of the smaller Kays has been to a great extent, for the same reason, given up; and amongst other instances, I remark Great Tobago, the former owner of which narrowly escaped starvation; a heavy ground-sea setting in and making all communication with the larger islands impossible, while the Kay itself having been only recently cultivated, had no resources of its own to satisfy the wants of the inhabitants for any length of time. Guana Island labours under the same disadvantages, and all communication is sometimes for weeks interrupted.

The northern shore of Anegada is almost constantly exposed to a heavy swell, but in a severe ground-sea, the waves approach "mountain high," and when drawing near the island, appear as though about to precipitate themselves over the land, which very likely would be the case, were it not for the protection of a continued barricade of coral reefs. The breakers, however, have forced up sand which forms small hillocks on the north-western part of the island, the largest being even forty-feet high; and the parts behind these hillocks have been also thus inundated, a second and even third range of hills being there formed of inferior size, the sand of which is now consolidated and covered by a species of *arundo* and the *suriana maritima.* After these little hillocks have stretched for some miles in an easterly direction, the shore takes a rocky appearance, and instead of sand, detached pieces of limestone and coral are heaped up, reaching often a height of thirty feet and more, forming a protection to the land behind; which otherwise would be scarcely sufficiently defended, as the reef approaches here almost to the shore, and consequently does not break the force of the waves, the velocity of which is the more increased by the coast-line here forming a sharp angle.

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* A bay on the southern side of Great Tobago is remarkable for the regularity with which the breakers grind down the angles of such pebbles as are too heavy to be transported, and become now the sport of the surge. Pieces of granite, in which hornblende prevails, receive a perfect elliptical shape, as if they had been formed by the chisel and compasses. I have several specimens in my collection of geological series of these islands which are really beautiful. Jasper, in consequence of its more slaty nature, does not form a spheroid, but its upper surface becomes flat, and it is distinguished by its stripes of different colours, and its perfect smoothness, as if it had been polished.

There extends from the western end of Anegada, in a south-westerly direction, almost to the eastern end of Jost Van Dyke's, a shallow ground, consisting of transported sand heaped up, perhaps for ages, and which may be considered as the parent of most of the shallows in Drake's Channel.*

The tidal stream, which flows over this bank, and which, during the flood-tide, runs to the south, finding its way obstructed by the Island of Tortola, sets along its northern shore almost in a western direction till it flows between the west end of Tortola and Thatch Island, into Drake's Channel; here it sets east, and escapes between St. John's and Norman's Island. The transporting power of the waves, the average velocity of which cannot be considered to be more than two miles in an hour, would be scarcely strong enough to remove quantities of sand and deposit it in other situations: but the waves, during a ground-sea, having once torn up particles of sand and set them afloat, they are easily transported by the tidal stream; and the discolouration of the sea and the different tints of the water, already described, are nowhere more observable than in the direction of this extensive bank. The sand which thus escapes is transported to a greater or less distance until it is deposited: the check being produced by some projecting point or contracted channel, through which the tidal stream forces its way, or by the counteraction of the respective tides; and thus the foundation for a sand-bank is laid.

I have found several shallows to the northward of Thatch Island

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* I have carefully sounded this bank, but as I do not find it noted on any of the previous charts, I do not know whether it has increased or decreased. It is known by the name of the "Middle Ground;" and its least depth was, in 1831, seven fathoms and a half.

and Tortola, which are not in the old charts: whether these banks escaped the surveyors, or whether they have been formed since the late Spanish surveys, can only be left to conjecture. It has been stated, that the ground-sea has its origin between the islands which are subjected to it; but the fact, that a severe ground-sea often rages on the northern shore of Tortola, whilst on the northern side of St. John's there prevails a perfect calm, contradicts this remark, and is another proof that we must look far out at sea for its originating cause. The Island of Tortola protects almost completely the northern side of St. John's, and prevents the waves from having effect. Where St. John's is exposed to the open ocean, as between the two islets, Whistling Bay and Mingo, we find the ground-sea raging again, and the bays protected by coral reefs.

To one who crosses, during a severe ground-sea, from the southern side of Tortola to the northern, where the breadth of the island is but inconsiderable, the strange spectacle is afforded of the sea, which on the southern side is perhaps "as smooth as glass," on the northern shore tossing, foaming, and roaring, as if agitated by a severe gale. The effect is most curious, and if it were not for the warning that is heard long before the cause becomes visible, one might fancy the wand of a magician in play.

The northern coast of Porto Rico is subjected to a ground-sea, of scarcely less force, which has had the same effect on its coast as at the Virgin Isles. The 'Old English Pilot' observes, that the sea along the north coast of Porto Rico "eats sometimes very ragingly." The force of the waves that batter against the cliffs on which the Moro stands is amazing; and any observer will agree with me, that the spray is sometimes carried more than a hundred feet high. I was told that, several years ago, a brig, in consequence of carelessness, became here unmanageable, and was soon dashed to pieces against the cliffs, but few of the crew escaping.

In order to arrive at accurate conclusions whether the opinion which I have formed of the originating cause of the ground-sea is correct or not, it would be curious to compare the log-books of vessels crossing the Atlantic when there were heavy ground-swells on the shores of the Virgin Islands; making allowance for the time which must elapse before the effects of a storm can influence the sea along these shores, and also paying regard to the magnitude of the waves, as on that circumstance depends their velocity.

The obstacles opposed to the tidal wave between the Virgin Islands cause great irregularity in its set and velocity; and though coasters reckon upon a windward tide from the moon's rising to her zenith, and upon a leeward tide from her zenith to her setting, no dependence can be placed on this, the tides differing often one or two hours, so that the change from ebb to flood sometimes precedes the rising or setting of the moon, though it more commonly succeeds it. The windward tide, or that which sets to the south and comes from the Atlantic, on running through these islands makes high water, whilst the ebb or lee tide sets to the north-west. The flood tide, very probably, does not extend far south, being there overcome by the currents existing in the Caribbean sea, swelled by the flow of water which issues from the large rivers Orinoco, Essequibo, Amazon, &c.; and the northern or lee tide I conceive to be of still more limited extent, being overcome by the general W.N.W. current so soon as it leaves the Virgin Islands.

Through the greater part of the year an almost regular tide takes place alongshore among the Virgin Islands; but it is different in mid-channel, where the flood-tide continues to run south, while the ebb has already commenced to set to the north-westward alongshore. As an example, on the western and northern shores of Tortola, the flood acquires its highest level, at full and change, at ten o'clock; and the same takes place fifteen minutes later on the southern side. But at mid-channel, between Tortola and St. John's, it continues to flow to the windward for an hour and a half to two hours longer. The pressure of the ebb-tide appears, however, to be of minor force, perhaps from the circumstance that the flood-tide comes from the main ocean, whilst the ebb has not so extensive a range; and, consequently, the difference of the time between the reflux of the tidal stream near the shore and mid-channel is not so considerable as in the former instance, seldom amounting to more than from thirty to forty minutes.

The time during which the flood-stream continues to run to windward in the middle of the channels (*i.e.*, between shore and shore of the different islands) is not everywhere the same among the Virgin Isles, but suffers great modifications; and whilst to the east of Mary Point (the northern angle of St. John's) it often amounts to an hour and a half, or two, it is scarcely more than forty-five minutes to the westward of it. Droghers or coasters, acquainted with this fact, when bound to the westward, make short tacks alongshore from Mary Point to Pelican Bay, avoiding the shore of Tortola as much as possible, and thereby escaping much of the influence of the north tide; whereas vessels less acquainted, using the whole sea-room afforded by the channel, are much retarded in their progress.

The direction of the tides is also much cut up and altered in force by the winds, and various impediments which present themselves in the form of promontories, narrow passages, reefs, shallows, &c.; and it is only with time and by experience that a navigator may become acquainted with the different sets in the channels and passages. During the period that I re-surveyed the Virgin Isles, I paid particular attention to this subject, and I must freely confess that it was full of difficulties. The accompanying sketch of the Virgin Islands, on which the different courses of the tides have been represented, will elucidate the following remarks:—

There are four great outflows for the southern or flood-tide, namely,—1. Between the western end of Virgin Gorda and Peter's Island, which space affords passages to the tidal stream entering between Virgin Gorda and the islets to the east of Tortola. The conflux of so many branches creates necessarily an eddy tide, which we find to the east of Scrub Island. The chief mass of the stream directs its course thence westerly to the passage between Salt and Peter's Islands, a branch escaping between Broken Jerusalem and Round Rock.—2. Between Norman's Island and St. John's. The stream to the west of Road Harbour, in Tortola, and to the east of Mary Point, at St. John's, are directed towards this passage, and unite to the north-east of Red Point, at St. John's, one branch flowing thence towards Ram's Head, and the other to the south-east.—3. Between the western end of St. John's and the eastern end of St. Thomas. The southern tide is here of considerable strength, and causes nowhere between these islands so heavy a swell, the waves becoming often mountains high, and the extent of water over which the eye sweeps offering the aspect of a raging war between wave and wave. After having cleared the passages the stream of the flood-tide directs its course towards Frenchman's Cap, or Bird Island, with the exception of a branch which runs towards Reef Bay, in an eastern direction.—4. Between the western end of St. Thomas and Culebre. A branch of this great outflow sets through the passage between the western end of St. Thomas and West Bay, running off towards Brigantine; a stream strikes, however, to the south-east. Having cleared the different passages, the southern tide is now acted upon by the trade-wind, and flows off south-west until it is turned by the current existing in the Caribbean Sea. I am inclined to think that its whole range does not amount to more than 60 miles.

The ebb-tide, with a few exceptions, takes a more decided north-western direction. Its first great outflow is between Guana Island and Tortola, its second between the western end of Tortola and Mary Point, and its third between Green Kay and Thatch Kay. The velocity with which the northern tide runs through these three passages is nowhere surpassed, though it has a great many by-ways for its outflow, which the map will point out. From the harbour of Tortola a stream of the ebb-tide sets easterly, which is again met by another coming from the passage at Peter's Island, and by a third from the Round Rock passage; they unite off the southern bluff point at Beef Island, causing an eddy tide and a considerable swell.

Frenchman's Bay is divided from the mainland of Tortola by a small and shallow channel; generally speaking, the tide here sets west. This would be its natural direction during ebb-tide, and the reverse during flood; but at that period the tidal stream running with great velocity through the passage between Tortola and Thatch Island, it finds itself a second time compressed by the narrow passage between Frenchman's Bay and little Thatch Island; the waters on escaping this compression extend and come in contact with the bluff at the tower, and a re-flux takes place towards the passage, which acts as an in-draught, forming consequently at flood-tide an eddy race around the whole island.*

This passage is said to have become deeper within the recollection of many of the inhabitants; if this be really the case, it must be in consequence of the transporting power of this local current.

The velocity of the tides between the Virgin Islands depends very much on local circumstances. Where two streams unite, after having made their way through different passages, the velocity is generally increased. The southern tide is of considerable force between St. John's and St. Thomas's; I have known that tide to be so strong, that six able boatmen could make no progress or head way for hours; it must then have run at the rate of five miles.† The same is the case between St. John's and Tortola shore. But the north-western tide is of still greater strength than the flood-tide, though the latter comes from the Atlantic: the prevailing current in the latitude of these islands setting W.N.W., the flood-tide has to overcome its opposing force, which weakens its velocity. This is not the case with the ebb, where the set of the tide and current being nearly the same, the latter adds its force to the first and increases its velocity. I have seen many vessels, on beating through these islands during a north-western tide, fixed to one and the same spot for a considerable time; and others come to an anchor, relinquishing the contest with so heavy a lee-tide. The tides have their greatest force at springs, but especially at the day of full and change; and the tide which happens at the time this takes place is considerably stronger than the previous one. The velocity of the northern tide is strongest between Beef Island and Comanoe, and it is often impossible to cross from one island to the other during such a tide. The attempt proved nearly fatal to Mr. L., of

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* Anegada, inside the reefs, offers a similar instance on a larger scale: the current is here however permanent, which is not always the case at Frenchman's Bay, but chiefly when a strong northerly wind prevails during the period when the southern tide is predominant.

† I scarcely need to observe, that when miles are here spoken of, nautical are intended, 60 of which make a degree.

Beef Island, who, returning from Comanoe, thought himself strong enough to contend with the opposing tide, but was soon deprived of his oars, which were instantly swept away. Finding that the northern current set him to leeward he used the seats of his boat as paddles, which met, however, the same fate as the oars. Meanwhile the tide changed, and at day-break he found himself drifting towards the Round Rock passage. Without fresh water, or a morsel to eat, his boat became the sport of the changing tides for the next two days, sometimes so near Beef Island that he could not think but that the boat would be drifted ashore, and a southern tide then sweeping him towards the Round Rock or Broken Jerusalem. Nearly overcome by hunger and thirst, and given up for lost by his relations, he was at last discovered, on the third morning, by some people from Spanish Town, who hastened to his assistance.

A very strong northerly tide runs likewise between Tortola and Thatch Island, which but lately offered a more tragical instance of its force. An African purposing to return from Belmont estate, at Tortola, to Thatch Island, late in the evening, on finding that his companion declined to set off at so late an hour, thought that he could manage the boat alone. He was never seen again; the keel and broken timbers of the boat were found on the eastern end of Thatch Island, and told his fate. Not able to stem the tide, his boat was probably driven against the rocks and split to pieces. The oars, some time after, were picked up in one of the Bays on the north side of St. Thomas's.

The tides are so powerful in some of the passages between the smaller Virgin Islands that the buoys attached to the ropes which indicate where the fish-pots are placed, sink so that the fishermen cannot haul them except at slack tide, when the buoys become again visible. The great strength of these tides is, however, only partial: their average velocity in general does not exceed a mile and a half or two miles, in ordinary cases, in the channel, and probably decreases at some distance out at sea.

The medium of the perpendicular rise of the tidal wave between the Virgin Islands does not amount to more than two feet, being at spring tides 26 to 36 inches, and at neap tides 16 to 18 inches. These comparatively low tides tend to prove how little tide there is in the Atlantic near the equator; and though there is no great range of coasts to produce a considerable elevation, the narrow passage and channel of which this group is composed might have led us to expect a different result. The accumulation of water in consequence of the trade-winds and the equatorial current, may, in some respects, prevent a higher elevation; and accordingly we find that beyond these latitudes the tide rises to a greater height, even where the range of coast is not so extensive, as from 8 to 10 feet at the Canaries,—from 4 to 6 at the Cape Verd Islands,—and from 5 to 6 at the Bermudas. The sandy shores and beaches of the Virgin Islands are flat, or very gently sloping, which we may take as a proof that the tides have never been of greater height there, at least not for several ages; and the progress of the tidal wave must consequently be very trifling.

The southern tide is predominant during the summer months, *i.e.* from the middle of June to the middle of August; and two tides have been then known to follow in succession, chiefly if the wind has been westerly. The consequence was that the perpendicular rise of the tidal wave was considerably increased, and, as an extraordinary case, the water reached the height of three feet.

There is another circumstance which deserves to be particularly mentioned. At the period when the southern tide becomes predominant, which is generally in the middle of June, the tide sets for eight or ten days continually to the south, with a force very seldom surpassed. It is called by the fishermen 'the St. John's tide,' the day of this saint occurring about that period; and commenced last year on the 12th of June, lasting to the 21st of the same month. The seine-boats could not round fish for the whole week, nor were the fishermen able to discover their pots, the buoys being all sunk. At other times the ebb sets to the north for the course of an hour or two, when the flood begins to flow again to the south.

During the months of September, November, March, and April, the northern tide is prevailing, and of considerable force, being assisted by the current. At this period also the highest water is generally in the morning, and there is only a half-tide in the evening; the reverse takes place during the summer months.

In estimating the transporting power of tides in general, we must be careful not to consider it the same as that of the currents of rivers. It has been stated that a velocity of three inches per second at the bottom of a river will just begin to work upon fine clay, and, however firm and compact it may be, will tear it up; a velocity of six inches will lift fine sand; eight inches, sand as coarse as linseed; twelve inches will sweep away fine gravel; twenty-four inches will roll along rounded pebbles an inch in diameter; and three feet per second will sweep along shivery angular stones of the size of an egg (Encycl. Brit., art. *River*). Considering the average velocity of the tides between these islands to be two nautical miles (6120 feet = 73440 inches × 2 = 146880 inches ÷ 3600), this would give forty-one inches per second, a greater power than the highest above stated; yet even in the comparatively shallow channels, where we might conclude that the superficial velocity extended to the bottom, the water, nevertheless, remains clear during the strongest tide: thus showing either that the force or moving power of the tides at the bottom is not equal to their velocity on the surface, or else that their action is inferior to the moving power of river-currents. When the ground-sea is not prevailing, the water in the channels is even remarkable for its clearness, and strangers are often alarmed by seeing the bottom distinctly in eight and nine fathoms water. I have myself distinctly observed at that depth a peculiar kind of sea sponge called 'Java pots' (a species of Alcyonum).*

The unchanged character of soundings for a length of time in places which have been surveyed with accuracy, and to the results regarding which implicit confidence may be given, has attracted already the attention of geologists to the fact, that the transporting power of tides is small. Nevertheless, where channels are contracted, and the general depth is not considerable, and the velocity is increased by other obstacles, they will produce some change at the bottom of the sea, chiefly by affecting the shape of sand-banks where they approach the surface, and are thus besides subjected to the disturbing power of the waves.

There are few rivers which during freshes do not convey a quantity of detritus into the sea, and if their mouths are tidal, this detritus is committed to the charge of estuary tides; if they be tideless, generally deltas are formed. Few of the rivers along the north-eastern coast of South America are tideless, and the quantity of detritus borne down by the Orinoco is carried forward until local currents turn its direction and convey it to distant shores or shallows. In a paper on 'Anegada,' published in the Journal of the Royal Geographical Society of London, (vol. ii.), I invited attention to the existence of a current passing that island in a W.N.W. direction, and which I conceived to deposit detritus on its shores.† To this current and its transporting power we must look for the origin of the large sand-bank which extends from the western end of Anegada to within a short distance of the Island of Jost van Dykes, and which is called the middle ground. On its passage along Anegada the current is influenced by the tides of the Virgin Isles, and delivers part of its detritus to the tidal stream, which the usual check of the counteracting tides causes to be deposited. The greatest extent of this bank is in a south-westerly direction twenty-two nautical miles, whilst its breadth varies from one mile and a half to three miles, proving in a striking manner that the flood-tide deprives the current of the detritus which composes the bank. The action of the waves during a gale or a heavy ground-sea possesses more moving power than a tidal stream or current of the greatest velocity; and the sand, once detached from this bank, is set afloat and carried forward and backward by the tide until deposited.

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* Mr. Maclean, a gentleman in Tortola, high in scientific attainments, drew my notice to another phenomenon, which may be observed in the channel between that island and Jost van Dykes, namely, a counter current at a depth from two to three fathoms, to which his attention was first attracted by seeing pieces of wood, &c. moving in a different direction from those on the surface: this statement I afterwards corroborated by my own investigations. In calm weather, when the surface of the sea was unruffled, I went out in a boat, and having attached a lead to a line, to which at intervals of a foot small pieces of deal wood were tied, I threw the lead where the tide was running strong to the south; the upper pieces of wood, consequently, floated in that direction, but those at the depth of eleven feet and upwards pointed to the northward. Either the moving action of the tide, therefore, only extends to that depth, or this arises from the W.N.W. current, which, though too weak between the islands to resist the strong southern tide at the surface, extends to a greater depth than it, and keeps its original course lower down.

† While on the subject of this current, it may perhaps be interesting to observe that I have received since the publication of the above remarks two proofs which are sufficient to substantiate my surmises with respect to this current. In the latter part of 1831 a bottle was picked up on the southern side of Virgin Gorda, which, according

If we cast a glance on the accompanying tidal map of the Virgin Isles, we observe that wherever the stream of flood directs its course through one of the passages after having passed over the middle ground, a sand-bank of more or less extent has been formed. The stream of flood being opposed by the reflux, by headlands, or contracted channels, by sunken rocks, or any other

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to a paper inclosed in it, had been thrown from the ship "Gambia" in the River Gambia; and on the 8th of January, 1833, another bottle was picked up on the northern side of Anegada which contained a paper now in my possession, of which the following is a correct copy—

"*Currents of the Ocean.*—The bottle containing this note was cast overboard from the bark Emerald of London, bound to Jamaica, the 17th day of December, 1831, in lat. 36° 40′ N., and long. 12° 32′ W. by chronometer. Whoever finds it is requested to forward it to the editor of any newspaper who may be kind enough to notice it for public information.

"C. W. Nockells, Commander.
"(Signed) "C. O. Hodgson, } Passengers.
"E. M. Geachy, }

"Note.—Two bottles are thrown overboard here, both of the same import. Two more were also cast overboard on the 5th inst. in lat. 41° 48′ N., and long. 13° 49′ by chronometer. The winds for the last three days have been from N. and N.W. to S.W. For eight days previous it blew a continued and heavy gale from S.W. and W.N.W., lying-to the whole time, and drifting from lat. 41° 28′ 237 miles to the northward."

The southern current along the coast of Spain and Portugal had probably drifted this bottle towards the mouth of the river Gambia, where it may have been taken up by the western current and drifted towards Cape North, and thence by the N.W. current to the shores of Anegada. If we calculate, therefore, the direct length of the three main courses of the currents, we have a distance of 4796 nautical miles, and the bottle having been taken up on the 743rd day after its having been thrown in the water, supposing it to have been drifting continually during that period, the mean velocity of all three currents would be ·26 knots in an hour, or nearly seven miles in a day; the difference in the winds, and perhaps other circumstances and detentions not included.

The above calculation of the velocity of this current is necessarily vague; nevertheless, it may afford an addition to our knowledge of the general velocity of currents; and the drifting of these two bottles establishes the truth of my former remarks regarding the current passing Anegada.

obstacles, however small, is forced to deposit its sandy particles; and the foundation of a sand-bank once laid, it is well known how soon it accumulates.

The shallows in Sir Francis Drake's channel are, therefore, derived from sandy particles which have been carried from the extensive bank to the northward of the Virgin Isles, and which the flood-tide has deposited. I do not think that the shallows have shifted much since their existence, in consequence of the nearly equal counteracting effect of the tides; we may find them, however, somewhat increasing towards the northward, because, as already alluded to, the northern tide is, generally speaking, the stronger of the two; and though the flood-tide carries the sandy particles in its train, it is the northern or ebb-tide which causes them to be deposited. At this moment these sand-banks can scarcely prove of any danger, and I doubt much whether they ever will be so, unless some violent convulsion of nature or a hurricane of uncommon strength should detach such a quantity of sand from the middle ground and from the land, that changes of more serious character than ordinary should be the consequence. The shallowest part in the channel is abreast of Peter's Island, where there was in February, 1833, only four fathoms water.

Before I conclude these remarks, I shall add some observations which may prove of advantage to the navigation of these channels. The passage between St. John's and a small bay lying midway between the former and the eastern end of St. Thomas' is often selected by vessels bound for St. Thomas', and which may have made the Virgin Islands to the northward of them. This should not be attempted, however, when there is a northern tide, and the wind any way to the south of east, as vessels will then almost certainly be set on the reef, being unable to stem the force of the northern tide, which is so strong here that droghers have given this passage the name of "the current-hole." This passage is especially dangerous during the spring months, when the northern tide is stronger than at any other period, and the instances are not few of vessels having been set upon the reef in this direction when the danger was quite apparent. When the tide sets to leeward, vessels beating to windward through Drake's Channel should make short tacks along St. John's shore as soon as they have reached Mary Point, or else stand over towards Jost van Dykes, and try to fetch the passage between Thatch Island and Tortola; having reached Pelican Bay or Witch Island, the northern tide trends to the eastward and favours a vessel as far as the north-eastern entrance to Drake's Channel. Should the tide, however, have changed meanwhile, and at her arrival off Beef Island be flood, the stream there branches off to the south-west, and short tacks should be made along Beef and Scrub Islands until the Kays called the Dogs are weathered. Should the contrary be attempted, a strong southern tide is apt to set the vessel towards the Round Rock or Broken Jerusalem, and some efforts would be necessary to make good what has been lost. Vessels beating to windward outside of St. John's, when there is a southern tide, should keep the land aboard as much as possible: it is, however, different when the tide runs to the northward, when they ought to stand out.

II.—*Extracts from private Memoranda kept by Lord Prudhoe on a Journey from Cairo to Sennar, in 1829, describing the Peninsula of Sennar.* Communicated by Sir John Barrow, Bart. Read 9th February, 1835.

March 10.—KARTOOM is situated on the Bahr-el-azrek, about two miles from its junction with the Bahr-el-abiad; it has only sprung up into a town within four or five years, in consequence of being fixed upon as the residence of the Sandjar or governor, who is lodged in a tolerable house of mud. There are about thirty other mud houses in the town, the rest being built of doorah-stalks;—both with respect to walls and roof, they resemble small wheat-stacks or bee-hives.

There are no trees, and the position appears to have been chosen for its bare, ugly plain. Courschied Bey governs from Berhee to Sennar, and receives in pay 680 purses a year, 3,500*l*. There are barracks for the Nizam (800), whose commander is the Kaimacam, lieutenant-colonel. The climate is healthy except during the Khareef (after the rains), and at that period Sennar is the most healthy of the Soudan possessions of the Pacha. The natives are of two sorts, the free cultivators and the Mowelled. These latter are a peculiar race: they are descendants of slaves, who from generation to generation live at large, and pay their masters monthly a part of their gains, which the men derive from labour and the women too often from prostitution. If two slaves of different masters marry, the children become their joint property; and it is not unusual for six or even more masters to possess as property a single slave. If a woman has a child without marriage, it belongs to her master. Some of the great Sheicks have five or six hundred Mowelled, who may be sold like other slaves, and are frequently light-coloured and handsome. In appearance there is no difference between the Mowelled and the free population. The proportions of each depend on the state of society of the district: thus, in the island of Sennar, the great majority were Mowelled, while in Dar Shagei there were hardly any. The whole country to the south of Khartoom, bounded on the east by the Bahr-el-azrek and on the west by the Bahr-el-abiad, is called

the island of Sennar, though in reality it is joined to Abyssinia on the south base of the triangle. Before the conquest by the Pacha of Egypt, this country was commanded by the Muck or Melek of Sennar, who now lives in happy indolence on the splendid and never-paid pension of 500 piastres a month (6*l.*). The bazaar of Khartoom consists of twenty sheds, where corn, coffee, and black sugar are sold at a high price; and where are retailed a few looking-glasses and glass beads for necklaces and bracelets,—ornaments generally worn. Every article of luxury comes from Cairo, and during its journey doubles or trebles its price. Occasional arrivals from India bring preserved ginger, sugar-candy, &c.; but these supplies are rare and small in quantity. There are no Arabs here, and we find a difficulty in getting camels or dromedaries.

March 11.—No dromedaries. A day of great heat, 28°.

March 12.—Dr. Romin came commissioned from Courschied Bey to make every apology for his affront to Mahomet, which he said was caused by a moment of irritation after twenty-four hours fasting; that when Mahomet asked for the boat he did not say it was for us; and that he would send his chief counsellor to offer his apology to-day, when he trusted we would forgive him, and dine with him as a proof of friendship. At sunset Ibrahim Cachief, the said chief counsellor, arrived, offered the same apology, which we accepted, telling him that I expected he would receive me standing, and get up when I went away. Ibrahim Cachief replied, "Oh, certainly; any thing you please—every thing you please." We mounted the horses the bey had sent for us, and rode across the place. When we arrived the bey was still at prayers in the court-yard; as soon as he had finished we entered, and he repeated all his excuses, with which I told him, of course, that we were satisfied. In a short time an immense dinner was served: plate followed plate, till, as a *pièce de resistance*, a whole sheep was brought in roasted. The master of the feast showed all the delicate attentions of a Turk, tearing off the tenderest and fattest pieces with his fingers, and presenting them first to one and then to another. A pillaf plate of rice finished the repast. Selim Effendi, the young man who presented himself at our tent on Friday, brought me a basin to wash my hands in, presenting it on his knee. Coffee, with pipes or hargillas, were brought in, and we tucked our legs under us in repose The guests were Ibrahim Cachief, a respectable man with a black beard, who was towel-holder to the Pacha, and was therefore thought fitted for the post of chief counsellor to the governor of the Soudan country; the Cadi Effendi, or head of religion, one of the most finished courtiers possible,—he spoke in a low, insinuating tone,—his head lowered to the ground, and his eyes half closed,—saying our arrival at Khartoom had made the country green and his face white; and a Delhi

Bashi, commander of cavalry, a blunt soldier, who had just returned from the late invasion. Courschied Bey is a middle-sized man, of rather a severe countenance, but with much conversation; he had returned from a gazwah (incursion) in the Fazoogle country, above Sennar, whence gold is brought, and had levied contributions by taking all the gold, cattle, and slaves he could lay his hands on. He said the people, though armed with spears only, fought with great bravery, but that they were such savages, that husbands killed their wives and mothers their children, to prevent their being made slaves by the Turks. There is always difficulty in the marches during these incursions in the forests, from the rarity of roads capable of admitting above one camel abreast, and the heat of the weather obliges each soldier to have one to mount besides what are required for water and provisions. Water is also a want which causes at times considerable danger. Courschied Bey intends making a gazwah against the Aleish, a country where more than 500 villages have been established by the inhabitants, who fled from Sennar when the Turks took the country; they have never paid contribution. We left the bey at midnight, heartily tired of our entertainment. Soon afterwards the cadi effendi paid us a visit at our tent, and said that the bey loved us very much—that our words were sweet and our heads wise; he repeated, also, a prayer to Isa, our Saviour, and pronounced a blessing on us and all Christians, saying that any musselman who did not was a Caffre. He told us his ancestors were kings of Grenada; that he lived at Fez; that being a Mahomedan was a good thing, for every one might have four wives, and change them as often as he pleased; that all muzrebbins loved sweet things, and that our sherbet was the best he ever tasted,—of course he got another glass.

March 13.—We have much risen in the estimation of the Khartoom world. Major Felix is always called Meeralli (commander of 4000 men), and my title is Bezardeh (prince). A house made of doorah stalks, perfectly finished, was carried by two men from the place where it was built to its permanent situation. Some slaves taken at the Fazoogle gazwah were sold by auction at the governor's house, fetching nine dollars each; a woman and a small child reckoned as one man. These wretched objects had a wooden beam, ten feet long, fitted to the shape of the neck by a crutch, and bound behind; this long beam was supported on the march by the slave who walked before, and was not removed even at night, which prevented these wretched creatures lying down to sleep. The cadi and grand maalim, chief accountant, a Copt, paid no visits by day, and the sandjah at night came in state. He has lent us two of his own dromedaries, and sent for the best which can be procured on the Bahr-el-abiad.

March 14.—We got the bey's boat and rowed down the Bahr-el-azrek to its confluence, when we breakfasted on the banks of the Bahr-el-abiad. The banks of this river are low and flat, presenting a succession of grass lawn, and fine trees of the harrez (acacia). No scenery can be more unlike the Nile, while the Bahr-el-azrek is its *fac-simile*—the same high banks forming steppes from the annual inundations, bare of trees, but eminently fertile from the rich deposite of the river, while the Bahr-el-abiad, stretching into wide lakes during the inundation, leaves the soil so sterile, that neither corn nor other crops, not even doorah, can be grown when the waters subside; in lieu springs up grass, a production nearly unknown in Egypt. Here we saw a bird like the ibis, never seen on the Nile; it was black and white, with a curved beak, as represented in Egyptian sculpture: many of the picus species were also flying about, with feathers of blue and red. The fish, too, of the Bahr-el-abiad are peculiar to that river, and are not found in the Nile. A black-nibbed crow, black and white, not unlike in colour to the magpie, is common, and a very handsome bird. Near our tent at Khartoom the doctor showed the spot where a man had been taken off by a crocodile the day before our arrival. He was washing clothes in the river, the crocodile seized him and carried him to the opposite bank; another crocodile attracted to the spot wished to share the feast, and, after fighting for some time, they took to the river to settle the dispute, leaving the dead man on the sand-bank; a boat was sent over which brought the corpse to Khartoom. Mahomet, our cawas, and several others, witnessed the scene. Accidents of this kind frequently occur here, and fifteen of the Nizam have been killed by crocodiles since those troops have been sent to this country—six years. So much more dangerous are these animals here than in Egypt. We paid a visit in the evening to the kaimacam (lieutenant-colonel), who, the cadi told us, was an excellent man, who never spoke a word; nor was a truer character ever given than in this last particular. He sits on the divan from morning to night playing with his beads, and takes no charge of his regiment, but tells all who go to him on business to do as they please so long as they do not trouble him. Ibrahim Effendi, in consequence, is a sleek fat man; he was a Mameluke of the pacha; and when his colonel died some time since, he thought it unnecessary to trouble the Pacha or war minister with the event; and the Pacha heard of it by accident from a merchant. The kaimacam did not, therefore, succeed to the title of meeralli.

March 15.—One regiment of Nizam is quartered in the Soudan countries of the Pacha, of which, at Khartoom, there is one battalion of 800 men; at Misselemieh one battalion of 800; at Sennar, one battalion of 800; at Kordofaun, two battalions of 1600; the whole forming a regiment of 4000 men; besides a regiment of

Turkish cavalry of 400 men, under its Bim-Bashie, and another at Kordofaun of 400, making together 800; added to which are the few soldiers attached to each cachief, and the suites of the bey and kaimacams. The Nizam is composed of the Fellahs of Egypt, dispirited by their long stay in this country, by sickness and death. They are fine men, but badly clothed, fed, and paid. At Khartoom the battalion has lost a third of its number by death, and that at Kordofaun more than half. The ranks are filled up by black slaves taken on the gazwahs; and these troops, whose interest it is to leave slavery and a military life, are so little to be trusted, that on every expedition they desert with their arms if they find an opportunity; and every night in barracks they have their arms taken from them for fear of mutiny.

The bey played at djereed with his mamelukes and soldiers before our tent; at night we paid a visit to Ibrahim Cachief, the counsellor who had accompanied the troop last year up the Bahr-el-Abiad, and he gave us an interesting description of the expedition. Courschied Bey marched on the east bank, Ibrahim Cachief on the west. From Khartoom for four days the Bahr-el-Abiad continued a united stream. A small arsenal for building boats is established at Wadi Shallieè; and twelve hours farther brought them to the first island of the Shelooks, where a small sheick resides. This was to the Turks an enemy's country. For several days afterwards the stream of the river was broken by numerous islands. At length they reached Dentra, where also were many islands; and at the utmost extent of their journey, the river was so wide and broken by islands, that it was six hours' row from one bank to the other. Both the banks and islands were thickly wooded, so that it was scarcely possible to penetrate them; and beyond the wood on the banks was a vast plain, but no mountain.

Birds of the most beautiful colours abounded, and the lion, tiger, elephant, and camelopard were seen. The people of Shelook were men of enormous size, Ibrahim Cachief, a man five feet ten inches high, said he did not measure higher than their breasts. Both men and women went perfectly naked; they possessed neither camels nor horses, and the cattle which they had was probably plunder; the sickness after rains attacking both man and beast, and killing each alike. Their food is chiefly fish and dourra. They had numbers of canoes, some of which were said to be long, carrying sixty people. They were armed with spears, bows and arrows, and clubs. Their bows were so strong it was difficult to draw them, and they at times carried shields. They call their head sheick "God," and he alone is clothed with a cotton garment wrapped round his body loosely. When a prisoner is taken, he is carried to the sheick and asked, "Who made the world and caused the river to run, who gives life and takes it away?" Should he answer, "God," he is put to death; but if he replies, "You are the God who do this," he has a chance of saving his life. It seems, however, that the sheick is only the representative of a superior power, for when Courschied Bey received some of the principal Shelooks, they made him swear by the Sun to do them no injury, although they addressed him as God. They wore bracelets of ivory; and brought all the treasures they said they possessed as contribution, namely, a few elephants' teeth and the musk of the crocodile. Courschied Bey gave them haman (peace), and finding he could obtain no plunder from them returned: it is probable that no other expedition will again for some time be sent up the Bahr-el-abiad. After the peace was made, the Shelooks put to death all the stragglers they met with from the Turkish army. This account of these people agrees remarkably with the description given by Herodotus of the reception of the Persian ambassadors by the Ethiopians. The cadi called this evening while we were out, and finding no one else to flatter, told Mahmood he was a wise man, and made excellent sherbet.

March 16.—The bey sent a present of ten sheep, and abundance of fowls and butter, with many compliments—"choke selaam to the bezardeh and meeralli"—which was returned by a barrel of sweet biscuits and a case of sherbet. He sent to say he would show us a better djereed-playing this evening, and came accordingly with his mamelukes and soldiers before the tent. We are anxious to get away, but no dromedaries have arrived. Called on the cadi, who overwhelmed us with compliments, wishing, among many other extremely good things, that I might soon be King of England, and presented each of us with an embroidered handkerchief. Visited the grand Maalim, whose rooms were filled with slaves, Abyssinian and black. Talking of the chief natives of this country, he said that most of them were already dead. Sheick Hassan is in prison; he divided a vast tract of country with his brother Sheick Suleiman, and a numerous population depend on them. They have committed no offence, but they are too powerful. Two or three more heads off, such as these, and the whole country will be quiet. The Maalim is a Christian and a civilian.

March 17.—The bey and his mamelukes exercised before our tent, to show us the firing at a jar. The jar is placed in an open space of 200 yards. The cavalier puts his horse to full speed, the reins are attached by a small string to the little finger of the left hand, the gun is held with both hands over his head, when about twenty yards from the jar he presents his piece, fires, and wheels his horse to the right. The bey was the best shot, and is a good sportsman. He, too, is a mameluke of the Pacha, and was his pistol-cleaner. In the evening we called on him, and he told some of his sporting anecdotes with great good humour. He had more than once been in difficulties with elephants and lions, at times afraid to chase the lion, and ashamed to run away, but at last he was generally obliged to trust to his horse's legs, and go off at a gallop. I gave him a musical snuff-box, which amused all his divan—soldiers, Arabs, and natives being called in to look at it. Sheick Moosa, a good-humoured Arab, full of marvellous tales, called on us; he is a captain of engineers, and has learned some smattering of drawing and observations—he brought a map of Egypt which he had made, a rude attempt. He promises to be our journalist for any future expedition up the Bahr-el-Abiad. Slept at Roummeait, to be ready to start at day-light.

March 18.—Leaving the greatest part of our baggage at Khartoom, we set off at sunrise. Major Felix and myself mounted the bey's dromedaries, with a one-eyed fellah to take care of them, and ten dromedaries with four Arabs of the Goreyat tribe, who occupy the west desert below Khartoom—making with our guide fourteen. In three hours we reached an open wood of fine acacias, and a small hillat (village) called Sobah-el-Howeeza. Here we halted to visit the remains of Soba-el-Sharkeeza on the opposite bank, having left orders for the caravan to stop for us. When half way across the Bahr-el-Azrek, four hippopotami (*Essint*) rose in the river and played about: one followed the boat, to the great consternation of the boys who ferried it over—they said it would upset us. The profile of its head and crest was like a horse, of a greenish colour, but its front face was of immense breadth. We sat on the shore for some time watching their gambols. They followed each other, at times dived, then rose again with a great splash, and swam with their heads and necks out of the water; at length they dived and disappeared altogether. We walked on to find the ruins of Soba; every one we met fled from us, so that it was not an easy matter to find a guide—at last a man at a sakee pointed out some mounds (near a wood) in the desert; we walked over them, but found nothing to repay our search. Mounds of burnt brick covered the site of an extensive town, but neither hieroglyphic nor sculptured stone was to be found. The remains might, therefore, be of any period. The country was open, with low wood, the banks of the river grow dourra, but the soil is sandy. We returned about one o'clock, heated, tired, and longing for breakfast; but the caravan had gone on, owing to the stupidity of Ali Cawas, who proves himself as incapable to be a khabeer (guide) of a caravan as he is to be of any other service. We were obliged to follow our caravan under a burning sun until that left us, and at seven o'clock coming up with our people at Nooba, united breakfast, dinner, and supper in one meal. The country was flat, with occasional patches of wood.

March 19.—As our dromedaries could not travel during the heat of the day, we continued only from daylight to nine o'clock, when we turned off the road to the village of Bishagary, a small place with good-looking people. It was Song market, and tolerably supplied, considering the deserted state of the country. Numbers of cattle are on their road north—the plunder of the last expedition. They are driven till they fall exhausted with fatigue and bad fare, and then left to the vultures and hyænas: hardly a fourth reach Egypt. Sixteen thousand have been taken this year from the cattle Arabs (Bukarah). The sheick's wife, a sister of Sheick Hassan, now in prison in Khartoom, gave up her house to us, and sent cakes of bread, for which she received necklaces, &c. At four P.M. we left Bishagary, and in three or four hours exchanged our wood scenery for a vast bare plain, which bore traces of cultivation. The soil of the Island of Sennar—one vast plain in this part—is capable of cultivation after the rains, when the dourra is sown. This being reaped, the land is left till after the next rains, each man raising whatever stock he requires for his family or for marketing—the usual small commodities, as perfumes of aloes, or a few cloves, &c., being exchanged for dourra measured in calabashes. At nine we passed Aboo-atkir, and partook of a sour sherbet called el salnaz. A paste is made of dourra and oil, which is left to ferment in the sun; it is then broken in small pieces, and steeped in water: its flavour is oily and disagreeable. At nine we stopped at a small hillat called Gemet.

March 20.—Started at five, and at ten reached the large hillat of Misselemich, situated on a bare plain, four hours from the river. The houses are built of dourra stalks, and form a crescent round a large square: in the centre is a deep well, the only one in the town. A few mud houses mark the dwelling of some opulent slave-merchants. This town is now famous for its market, and is the resort of many merchants from Souakin, who bring cotton, spices, and perfumes, to exchange for gold. Others from Abyssinia bring slaves, and a few horses, principally at the rainy season, when the east interior is more unhealthy than the banks of the Bahr-el-azrek, and flies then also torment the animals. We were well lodged by the principal merchant, Hadji Shóome, a stout old man with a good-natured countenance and easy manner, who, like all slave-dealers, was very punctual in his religious observances, and kept the fast of Ramadan with great strictness. He told us the late news from Abyssinia. Aklamaro, who had killed the Ras Goxa, and succeeded to the Ras-ship, has been in his turn slain by Yomaam, a son of Goxa, who is now Ras.

March 21.—We remained for the market to-day, which was of the same character as at Mettameer, but very numerously attended.

The men were all armed with spears and shields, wearing their knife-daggers over the left arm. Large parties of these wild figures rode into the market at a brisk trot on their dromedaries. The principal traffic was camels, and camels' flesh, dourra, fat, &c.; but the Souakin merchants and Hadji Shoomee bought gold with dollars for the India trade. The whole time the market lasted, Hadji Shoomee sat with his scales before him, weighing gold gratis to all comers. It was brought in pieces or rings of different sizes, from 30 paras (2*d.*) to 240 piastres (3*l.*) The gold is brought from the Fazoogle country, and must be in considerable abundance. In the late gazwah, Courschied Bey collected 1900 pieces of gold, fine as ducat gold. No other money is or has been used in the Island of Sennar than these unstamped pieces of pure gold. One of the amusements was throwing lances at a cock buried to the neck. The Sennar merchants are in appearance like the Bischaree Arabs, and speak their language as well as Arabic. They are rich, almost independent of the Pacha, and have the reputation of being turbulent, inhospitable, dishonest, and extremely bigoted; but they are a handsome and fine race, very cleanly in their persons, with bushy hair neatly frizzed and perfumed, and in general wear gold ear-rings. Another great merchant, Sheick Stambool, a nephew of Shoomee, insisted on giving us a dinner to-day. As it was Ramadan he could not partake of it himself, but he sat by to see ample justice done to his cookery. Twelve slaves, each bearing a large china dish of good things, entered the small apartment on the ground floor, and deposited them on the angareeb between us. The cooking was in the best Sennar style, and the pastry sweetened with honey, particularly good. After coffee and pipes, Stambool begged for a certificate of good conduct in case he should fall into the hands of the English as prisoner of war, or, as they call it, slave. The possibility of such an event has often been alluded to by all sorts of inhabitants of Egypt, as well as this upper country. The principal source of commerce here is slaves, who are either taken in war or stolen from Abyssinia, or sold from Darfur, and similar populations, where all are born slaves.

The prices are high, in comparison to Cairo, for children and young females: they are often sold for one hundred dollars. A healthy young man, who is well fitted for a soldier, is bought by the Pacha for twenty dollars, when offered for that price. Grown persons are never valued so high as children, who from education, or being brought up in their master's house, are thought to be more attached. The Abyssinians are, among coloured slaves, the most esteemed both for beauty and fidelity, but they are always more delicate, not bearing any work, nor eating other than wheaten bread—a luxury not common here. These slaves are not reckoned black. The next esteemed in beauty are the Mowelleds, or natives of Sennar, but they bear no good character for honesty or principle. The slaves from the Kordofan Mountains, to the south of Obied, and those from Darfur, are perfect negroes, not good-looking, but honest and faithful. At five we took leave of our hospitable entertainers, and at nine reached Welled Medina, where a battalion of the Nizam is quartered. The sound of the darabooka (drum made of an earthen bottle or vase, with a skin bottom) announced a fantasia, but it proved to be a funeral wail. The women were dancing. We saw one at Metameer. Here the women, after sprinkling ashes on their heads, rolled themselves on the ground.

We had hardly established ourselves on the angareeks in front of the sheick's, when the Maltese apothecary, Zemeet, in the service of the Pacha, paid us a visit, regretting that his principal, M. de la Font, was not with the Bim-Bashi. This French physician was a young man, and had been three years in the Pacha's service. On arriving at Cairo, he complained that they wanted to teach him to bleed, but he told the *imbecilles* that he could learn it at leisure among the blacks. On arriving at Sennar he made his apothecary a physician, and committed the hospital to his charge, till Signore Zemeet begged to abdicate a situation which brought him much trouble but no profit. He gained much credit with the Turkish colonel by the extent of his cures; for one day he discovered that one-half the regiment was ill, and took them into the hospital. In four days he discharged the whole of them again in sound health. If an invalid does not know his complaint, the doctor says, very naturally, "How should I know it?" After we had been a short time on our angareebs, M. de la Font arrived on a capering horse, and humming a French air. Finding we were in repose, he addressed himself to Mahomet, first begging his pardon for taking him for a Turk, and then making as many excuses for not taking him for a Turk, rattling away in half French, half Italian, and going off humming his French air in the same thoughtless manner as if he had been at Paris. From a Greek named Sciánee we heard some particulars of Captain Gordon, R.N., who arrived at Welled Medina about eight years ago, in the month of June, and died in ten days of a violent tertian fever which he brought with him. He was buried in a spot set apart for Christians. His object was to penetrate into the interior of Africa alone. Mahmood, our servant, accompanied him as far as Berber, and was then sent back. All his effects, including doubloons, spy-glasses, books, and observing instruments, were taken by Bozzari, the physician of Ishmael Pacha, who was murdered afterwards at Shendy with his master.

March 22.—Started at four; at six passed a grove of acacias;

and then continued along a plain till near noon, when we halted near the river, in a beautiful wood of very fine trees, near some huts. The banks of the river were high, and exactly like those of the Nile. In the afternoon we mounted again, and in three hours turned off the high road towards the river, to visit Melek Badee, the former sovereign of the whole country. He now lives in obscurity on the wretched and never-paid pension of five hundred piastres a month. In half an hour we reached the small village of Dakkina. About thirty straw cabins, in form like hay-stacks, and enclosed with hedges of dry thorns, form the domestic establishment of the muk or melek. His own residence was in two cottages of larger dimensions, and better built, ornamented at the summit of the pointed roof with the eggs and feathers of the ostrich on each cottage. The remainder of the village was occupied by 200 slaves, who cultivate the ground. Though it was only eight o'clock when we arrived, the muk was in bed. Angareebs were brought outside the houses for us, and in a short time a sleek, fat, but rather lumbering black man, with short, crispy hair, and a good-humoured face, but vulgar frank manners, came to us with the usual "ten times welcome"—" Mahababak ashĕra." This was the Muk Badee: he was dressed in a white coarse shirt, very full, and carried in his hand a high and large stick. He talked of himself without any feeling, called the Sandjar " his master," and spoke of the gazwahs which he had made with different governors with much complacency, where he is led about more like a slave than companion—kissing the hand of the Sandjar at entering—never receiving the pipe—and often not sitting on the divan, but on the carpet. Ismael Pacha granted him an allowance of three hundred dollars a month; Roustan Bey lowered it to one hundred, and Courschied Bey reduced it to thirty-three, or a purse, allowing him to form a little colony at Dakkina, free of taxes for ground, but to pay the tax for one hundred head of slaves, which Courschied Bey made him a present of, forty of whom only arrived, and they were none of the best. Mahmood applied to the Turk for milk, which was ordered. A shed was given to us—another to the servants. The muk retired to his bed again, and we to our angareebs.

March 23.—We remained at Dakkina till four o'clock. In the morning the muk came early to pay us a visit, and remained with the servants till we were up. While there, a soldier arrived who came to demand the muk's contribution for land. It was the first demand made on him, and the muk raved and complained of injustice, and claimed the promise made by Courschied Bey that he should pay no land-tax; " But," said he, " if I must pay, take it from the arrears of my pension, of which nine years are due." He appealed to all around if he had not received a free gift of the land for which he was now taxed—if he had not been promised one hundred slaves, of which he had received but forty; and with his fiery eyes, black face, white loose shirt, and vehement gesture, formed a remarkable contrast to the Turkish soldier, who, with placid countenance, sat listening in patience on his horse without moving; and when the muk had finished his harangue, told him he must pay, but that he might appeal to the pacha. Of course it ended as might have been expected: the poor muk paid his money. The family of Melek Badee came originally from Teysafaān, a country in Soudan, and at one time were masters from the second cataract to the Fazoogle country, and the frontier of Abyssinia. In the east, his dominion included Souakin and the coast of the Red Sea, and, on the west, Kordofan. The form of government was absolute monarchy. In the course of time the muks became too indolent to transact their own affairs, and the eleventh predecessor of Muk Badee appointed a vizier, who, like the sultan of the Caliphs, and the *maîre du palais* of the French, soon possessed himself of all power, though he continued to pay every outward mark of respect to the muk, whose slave he really was, and always called himself. The muk lived indolently on his angareeb, surrounded by slaves: his pleasure was being greased. All his children, except one, were sent to Abyssinia, and if that died, another was brought thence to supply his place. When it suited the vizier, he sent, with every mark of respect, to the muk to inform him that his hour was arrived. Two or three days were allowed him to prepare his grave, and then he was put to death by placing two razors on opposite sides of his neck, and pressing them together with cords. His son was then proclaimed. All orders were proclaimed by the vizier as the mouth-piece of his master. The form was—"The muk says."

Justice was well administered, and crime was rare. Theft was punished with death; but even in the late times of unquiet and contribution it is almost unheard of from Ess-ouan to Sennar, though it abounds in Egypt among the Fellaheen and Copts. The father of Muk Badee was put to death by his vizier, Mohammed Ablee Keylik, and Badee, then a child, was placed on the angareeb. Shortly afterwards he was deposed and sent back to Abyssinia, but returned on the death of Ablee Keylik, whose grandson, Mohammed Weled Adilan, became vizier. Mohammed Adilan kept Badee always a prisoner, and the vizier died about the time of the Pacha's invasion, and was succeeded by his brother, Edrees Adelan, who made good terms for himself with Ismael Pacha, while his sovereign is despised. He retains the government of a large district above Sennar, which pays annually to the Pacha, some say 650 ounces of gold, others 1200. His residence is at Goola, a mountain some days distant from Bahr-el-azrek, where are good workers of iron, and some gold mines. There was formerly a trade between Sennar and India, by the port of Souakin. Cotton, spices, china, and some articles of use were exchanged here for unwrought gold. Such commerce partially remains. We found fresh Indian gingers selling; and last year sugar-candy was cheaper than the Pacha's dark sugar. The muks were always at peace with Abyssinia, but were frequently at war with the people of Denka and Shelook. The muk's account of them is, "*The Shelooks* live in the islands of the Bahr-el-abiad, above Waddi Shalliee. Their great sheick resides in the island of Abba, and is named Arweýga. They have quantities of canoes, which they manage with great skill, and are men of immense size and great courage. They wear no covering, and worship the sun and moon. *The Denka* live on the east bank of the Bahr-el-abiad, part of their country being parallel (in the same latitude) with the Shelooks, and a part extending beyond them. The capital town is Danāh, and their sheick's name Akone. They bury their dead in an upright position, and make of wood the head of a bull, which they worship. At the age of puberty both sexes have a tooth drawn from the upper jaw. Among the Shelooks Mariam is not an unusual name for the women. Originally the Denka and Shelooks were the same nation, but they are now quite separate, and constantly at war. Both possess cattle in quantity, and are armed with long spears, which they do not throw, but, crouching behind their shields, wait the near approach of the enemy. When Courschied Bey went against Denka, not a man was to be seen during the day; but every night, and all night long, sudden attacks were made on his camp, though as soon as the troops were under arms the Denkas disappeared, to return when all was again quiet."

Great numbers of the population of Sennar are free, but great numbers are slaves. The muk possesses twenty or thirty thousand, and the viziers considerably more; these are the soldiers during war, and their labours supply the revenue—no taxes being ever levied. Their luxuries consist of numbers of slaves, ornaments of gold, and perfect indolence. The dress of the muk was a long and loose cotton shirt (ed jervéznee), a shawl thrown over the shoulders (il ferda), sandals (naalat), and a stuffed silken cap with long ears (tangeea): this last, the insignia of office, is now worn by Idrées Adelan; a sword-bearer is always at his side. The dresses of the brother and children of the muk are in no way distinguishable from his slaves. A long cloth is bound round the men's loins—in the presence of the muk it is not permitted to be thrown over the shoulders. Several of the princesses, of all ages, are dressed and employed like the other girls—the girdle of strings is only ornamented with shells; and they carry jars of water on their heads from the river, or attend the mereesa pots in the cottages.

The muk sent us dinner, consisting of large dishes well filled with soup, roast chickens, dourra porridge, and bread. The cooking was very good. When Ismael Pacha arrived here, the muk made him a present of 7764 slaves and 16,000 head of cattle. At four we took leave of our royal host, who wished me to be his ambassador to the Pacha, to relieve him of his griefs: an employment I declined. At eight we reached Sennar, the former capital of the kingdom, now nearly deserted, and in most of its extensive quarters showing heaps of ruins. The houses were of mud, and the actual ones are mostly of straw. It is situated on the river, in a bare plain, and looked, as we approached it, long, low, and straggling. Mahomet had gone on before to prepare us lodging at the house of Sandalòba, the principal slave-merchant; and a miserable house he put us into. After I had lain down, Suliman Cachief came to pay his visit.

March 24.—Sennar, the capital of the country, was formerly a large town, and not badly built: the only remains, in fine baked brick, is the mosque—the neat bronze windows are the work of India. When the Pacha conquered the country, nearly the whole of the population deserted the town and emigrated to the Aleish, a district on the frontiers of Abyssinia, ten days' distance to the south-east. The few who remain live in straw huts, with the exception of two or three slave-merchants, whose houses are of mud. The bazaar is wretched, and ill supplied. There are two workers in iron and silver, who execute their works neatly with very simple tools. Wanting an Arabic inscription on a silver cup, I went to one—he was employed finishing a knife; when he had done, he began hammering a piece of gold—he was in fact coining rings of a dollar each, in want of other employment. The names of this unstamped gold are the

	Piastres.	Paras.	
Abba	0	30	or 2½*d*.
Kism.........	7	20	worth half a dollar.
Carat	15	0	worth one dollar.

Ogeega (1 oz.), 240, or doubloon—16 dollars.

Coloured straw hats are made with great neatness.

We paid a visit in the evening to Suliman Cachief, a good-looking Albanian, about twenty years of age; he received us civilly at the old mud palace of the muk, now almost in ruins. He came into this country eight years ago, with a hundred soldiers, eight of whom only remain, the rest having fallen victims to the climate. So fatal is the sickness both to natives and strangers, that they all speak of it with horror. The Cachief said it was only a country for desperate men. There is a battalion of Nizam quartered here, under Bim-bashi Mohammed Effendi, who, with two hundred men, is now at Goléh, with Idrees Adelan, collecting contributions. The Pacha's sway extends about 200 miles above Sennar, and is divided into two commands.

The country on the Bahr-el-azrek is under Sheick Suliman, a powerful man, who is said to pay an annual contribution of 1500 ounces of gold. His residence is at Reyseras. The mountains about 150 miles to the south-west of Sennar, and 60 miles from the river, are under Idrees Adelan, who pays an annual contribution of 1200 ounces of gold. The town of Goléh, which is his capital, is said to be as large as Sennar, and to be famous for its workers in iron. He is called Sultan by his own people, and has a large court; he is said to be a man of talent, and of noble manners, and has been allowed to keep the slaves, to the number of many thousands, whom he had when vizier to Muk Badee. He is in great favour with the Bey. His territory extends to within four days of the Denka country; and as he speaks that language, he would be of much service to persons wishing to penetrate up the Bahr-el-abiad this way, which seems to be a route offering less difficulty than any other. By placing entire confidence in Idrees, through a recommendation of the Pacha, he would afford protection to the Denka country, and obtain the friendship of its sheick. By the Shelooks the road appears impossible except by force. The great difficulty is to pass the frontiers of such countries, where they fear the encroachments of the Pacha, and see an enemy in every white.

Near the town of Sennar are some gardens which produce lemons and vegetables; no other trees are near, and no other gardens in the country after Essouan. Last year herds of elephants came here, and were fired at by the Bey, who killed some, and this year they have not arrived. They relate a story of one, who observing a woman beat and wash clothes in the river, and afterwards spread them out to dry on the banks, approached her, and, seizing her, beat her to death upon the stones, and then spread her out to dry.

From the dourra two drinks are made,—*mercesa* (a beer), produced by putting a quantity of dourra into a hole in the ground till the seed begins to shoot, then drying it in the sun, grinding it, boiling it, and forming it into a paste. This paste is put into a jar, cold water is poured on it, and it is drunk and eaten in a state of fermentation. The taste is sour and disagreeable, but it is the delight of the people, male and female, who drink it to excess; this, and greasing their bodies, are the two great sources of happiness to them. The other, *billbil* (a cider), undergoes the same operation as the first, but remains in the jar with the water for a day or two, and is then strained off. The taste is better than that of the mercesa. We heard much of animals called marafeen, which approach the town in great numbers during the night, and are said to partake of both genders. The common opinion is that they are magicians by day and take the form of this animal by night. Major Felix went out with some Turks and brought one home. To get a shot a donkey was fastened near some ruins, behind which the party hid; the first bray of the donkey brought some of the numerous marafeens, who seemed hunting in packs, and in that manner they were easily shot. They measure six feet long from head to tail, and stand three and a quarter feet high, their appearance being more like the hyæna than the wolf—with short yellowish hair on the back, spotted brown on the breast, belly, and legs, and the tail of a bushy appearance, but thin and not long. It is a rusty scabby-looking animal, but curious. On looking at it I laughed at the report we had heard, as it was evidently a male; but on making an incision the natives showed me the milk, and that its young was not weaned.

March 25.—Suliman Cachief's information has guided our movements. We should see nothing to repay us by continuing up the Bahr-el-azrek, as we could not go higher than a few days, and must return the same road. The rains have already begun, and our time is so precious, that with all our haste we shall hardly catch the Elphinstone cruiser at Mocha, as she is to leave it the beginning of May. We have determined therefore to cross the island of Sennar to the Bahr-el-abiad; the distance in a direct line is two days, but we shall be obliged to make a considerable detour to avoid the Bukarah Arabs, who are plundering the country to repay themselves for the last gazwah, and indeed have never been subjected by the Turks. We shall have Selim Cachief for our guide, who, mounted on his horse, came for us to-day at half-past one P.M. We left Sennar, taking a south-west direction towards some mountains rising thence from the plain. In the course of our ride Selim Cachief told us an improbable story of himself,—that he was the son of Abler Rachman Bey, that he was born a cachief, and until twelve years of age lived in the greatest luxury. When his father was driven from Cairo, Selim escaped, and lived with his mother, a Georgian. He was allowed afterwards a pension from the Pacha, which he held only a few years, and was now reduced to misery, and served as a soldier to Suliman Cachief. Not being either Turk or Albanian, he was regarded by neither as a friend. A short time since his cachief bastinadoed him because he asked to return to Cairo. His appearance was in his favour, and his address mild and gentlemanlike; his dialect also showed him to be a native of Cairo; but we did not believe his story, thinking it more probable that he had been a mameluke of the bey's, and took the liberty of calling his master abou (father), as Courschied

Bey frequently did when discoursing of the Pacha. We passed the village of Adjamee and Wed-el-Sedger, containing thirty or forty houses; the first pays 2000 piastres, or 120 dollars, and the second 2400 piastres annual contribution. In four hours we reached Ahmed Tote, a larger and better village, of which Selim Cachief was governor. He received us very civilly, and gave us the best he had. To give an idea of the manner in which this country is taxed,—Hadji Ibrahim, the richest man, has a capital of 1000 dollars, and is compelled to pay annually 125 to the divan. All the rest in proportion.

March 26.—Set off at half-past six Our course west over a bare plain. At ten we alighted from our dromedaries at Selleck, a village of tolerable size. A Turkish soldier, who was to provide us with a guide, was here to collect contributions. Many reed bundles of cotton were piled up outside the straw houses. Two minutes after we had arrived flames burst from a house where a woman was making mercesa; the wind was strong, and house after house caught fire with amazing rapidity; the dry thorns between communicating the flames. Each family rushed from their straw huts, and when they saw the danger ran back to save their cotton, angareebs, and few articles of furniture. I was astonished at the number of silver bracelets and gold ear-rings, ornaments for the head, or strings, which the women and girls wore. Afraid of the Turks, they never make a display of wealth. A cross of gold is not unusually worn, the remains of now-forgotten Christianity; it is called shegar (the true). All was confusion; the men seemed to take no interest in the fire when their own goods were safe for the moment, or consumed; and it was in vain we attempted to direct them how to cut off the fire. The nearest well was five miles distant, no water was to be procured. The women shrieked; the Turkish soldier flogged all indiscriminately with his koorbash; and we tore our skin and clothes among the thorn hedges, endeavouring to save the houses and property. The natives bore the loss with philosophy, though it amounted to 500 piastres or 33 dollars in some families. One young woman in her distress wished every Turk was in the fire and consumed like her house. We remained at Selleck till the fire was extinguished; perhaps fifty houses were consumed. An hour afterwards we reached Suggotee, situated under two mountains of rubble granite, with a well in the pass between. The scenery was pretty. Under the mountain were shrubs of bright verdure, mixed with the blocks of granite, and two villages were situated near. Trees and coppice joined this to the cultivated ground on an extensive plain which bears crops after the rains. Thousands of cattle and sheep were returning from the well, being pastured on the plain till night. We remain at Suggotee, as our next halting place is too far distant to reach before night. It is a very pleasant place. There are five villages situated at the foot of the hill; two on the east and three on the west side,—each with a soldier to protect it.

This being the frontier at present it is exposed to the Bukarah Arabs, twenty-five of which tribe, on horseback, made a descent ten days ago on Suggotee, and carried off camels and cattle; they were pursued, and their spoil retaken. The people are good-looking, civil, and good-humoured. The apes, which abound on the hills, come near the town in the evening, when the shadow protects them. There are many hundreds on the trees, and climbing about the rocks. Just before sun-set we took our guns to the wood, where there are also thousands of guinea fowl; they were tame enough to let us get within shot, and we brought home seven or eight brace in half an hour; they are much better than the West India species, and of good flavour; their colour is darker, and the birds are smaller.

March 27.—Started at five and travelled over a plain with some coppice. Saw a wild ostrich, who spread his wings, and trotted off at a quick pace. At noon we dismounted at El Azazey, a large, good, but forlorn village, situated in a sea-like plain without a tree. This district, like Suggotee, was attacked a few days since by a party of Bukarah Arabs, who are the terror of the country. The people are reserved and shy. Here we found a Fellah, who left Cairo with the Mamelukes; he denied Selim Cachief's being son of Abler Rachman Bey.

March 28.—Mounted at four, with another local guide; passed, an hour after sunrise, the village Wed Hamed, and at ten Abégone, where the people came out, took hold our bridles, and insisted that we should alight. They brought us milk and angareebs to a straw shed, saying "Mahababak Ashera." Their sheick, Abd-el-Hameed, took us to his newly-married bride, a mild feminine person, who was made happy with necklaces, ear-rings, bracelets, &c. All the girls of the village came round us also, and were delighted to share glass beads of all colours. Like the natives of the island of Sennar, they are bright-coloured, pretty, full of spirits, and not obtrusive. After breakfast we mounted, and were obliged to stop at Rebahab, in consequence of the illness of Yedallah (the hand of God), our Ababde guide, who came with us from Khartoom; he was seized with vomiting and pain in the stomach. He was bled, by having slight gashes cut in his leg with a razor. The Ababdes do not appear strong, and are much given to excess in eating and drinking. We amused ourselves with Sheick Ahmet and the people of Abégone for a couple of hours: they asked Haman (pardon) of me, Sandjak, and Major Felix, who with his long white shirt passed for Sheick Hassan. The usual compliment to us was "Mash allah rasak tezib" (long life to your honor's head). We mounted again two hours before sunset, and reached Maätoo before dark. Our course has been to-day westerly. On the dreary plain were a few patches of wood and some villages. The Bukarah passed in great force two days ago near Abégone. The sheick, a fine young man, received us at his house. He seemed to be a friend of Idrees, whom he called sultan, and appeared to have command, but was mysterious. His manner was mild and rather dignified. A strapping awkward Coord, who seemed just caught, also commanded here; he had arrived from Cairo a fortnight, and from his own country six months. He was all attention, but alarmed even at Mahomet's silver stick, and would hardly sit down in his presence.

March 29.—Were off at four. At seven reached the large village of Mussola, where we waited half an hour for another guide. The sheick was not civil, so we started again. After a brisk trot of two hours, Major Felix, Mahmood, and myself stopped at the temporary village called Aboo-el-Amera, which depends on Mussola. The inhabitants were very uncivil, and without threats of the sandjar's vengeance would not have brought us milk, nor would they willingly take money. The heat was very great, but at three we mounted and joined our caravan, which had halted among the tents of some Hassaneya Arabs. Many parties of ill-looking people have been about during this day, and our caravan had an affair at a well with some of them. The fray began by knocking Abouset and his dromedary into the well—it concluded by taking the culprits prisoners, who after being humbled were released before we came up. Abouset distinguished himself. Our angareebs were placed close to the sheick's and his pretty wife. A few glass beads were bestowed, and milk, &c. speedily produced. The men talked of the dangers of the place; the people about this country being robbers, and not hesitating to commit murder. They did not mention that they themselves are a tribe of Bukarah Arabs, the dread of the villages. Lions and other wild beasts abound here, and take off constantly the cattle and sheep.

March 30.—Just as we had packed up, and were nearly all right, we heard singing and clapping of hands, and to our amazement all the young women and girls of the camp advanced to our angareebs. The splendour of the necklaces had spread abroad, and each girl danced her best to gain a set of jewels. At last, in despair at the number, I produced boxes of rings, and after disposing of a few, these fair plunderers were so tempted, that, rushing on the prizes, they seized whatever they could get, and among the rest an old woman got my watch, which, however, the sheick recovered for me immediately. We walked through a fine wood for an hour, and burst suddenly on the Bahr-el-Abiad.

Monkeys and birds of gay colours were sporting on the trees. From the wood a lawn sloped gently to the river twenty yards. On the banks were birds innumerable: among them two species of ibis, one black, the other white, but black towards the tail, the heads of both black—pelicans, many sorts of geese, ducks, and other smaller water-birds. In the river sported a hippopotamus and two crocodiles. The opposite bank of the Bahr-el-Abiad, here broader than the Nile at Thebes, was wooded. We walked along the shore to the northward, looking anxiously for a conveyance across. There were many deep traces of hippopotami, and the recent marks of a lion, who probably had been to drink in the river a few hours before. Two have taken possession of this wood, and fattened on the Arabs' flocks for three years. A boat crossed over for us—it had been sent from Khartoom by Courschied Bey for our use. We crossed over and found Ibrahim Capitaun, a Cephalonian, boat-builder to the Pacha, at Wadi Shalliee. I discharged our caravan, who were left on the east bank, and urged them to depart immediately for fear of the lions. The Arabs were simple men; had never been in the island of Sennar before they came with us, and were alarmed at the idea of going so far from home. We took up our abode at Wadi Shalliee, at the house of Abdallah, a Dongolee, worker in iron and silver. The town consists of fifty or sixty houses—and a similar number are at two other places a mile off. The houses are of dourra stalks and matting, and are situated on the banks of the dry bed of the river, a mile from the water. At high water the situation must be beautiful; a thick wood backs it, and on their branches are monkeys innumerable, and many birds. The town cannot be accurately marked on the map, as its position is changed every year. The inhabitants are Hussaneya, a branch of the Bukarah, and wealthy in camels and flocks. While dipping our fingers in the greasy dish which a pretty slave of Abdallah placed on the mat before us, Bischara, the great sheick of the Arabs, paid us a visit. He was too fat and indolent to exert himself, even if it had not been Ramadan. He said no dromedaries were to be procured here for a journey to Kordofan, and it was late at night before he procured one, and a guide to go with Mahomet to the village of Mograt, six hours distant. Waddi Shalliee is only twelve hours from the first island of the Shelooks, who are as much dreaded by the Hussaneya Arabs as these last are feared by others. An hour from Waddi Shalliee is the island of Blood (gezerih iddem), so called from the massacres of the Shelooks; they are the first black people with woolly hair and negro character on the Bahr-el-Abiad. They make their attacks in great numbers. Eighty canoes, containing five hundred men, lately plundered a village called Torro, close to us here. The attack is generally, made at night, but the Shelooks (deeming it dishonourable to kill any one asleep) knock at the door, and call out "Hamet, hamet, Shelook!" in a moment all the Arabs escape, and leave the women, children, and cattle to the invaders. Hamet seems to be a name for strangers, probably from the prophet whose followers are their constant enemies. Wonderful stories are told of the prowess of the Shelooks, and their courage and skill in attacking the hippopotamus and crocodile while swimming, when they seldom fail to overcome them. The men have no names, the women are all called Mariam—marriage is unknown. The evening was beautiful, and we listened to a plaintive Bornou air which a slave girl sung while making bread.

March 31.—At three, P.M., Mahomet returned with bad news. The Kaimakam of Mograt was absent gathering contribution, and dromedaries could not be procured under ten or fourteen days. We therefore abandoned Kordofan, consoling ourselves with the prospect of gaining India by the sacrifice. On the banks of the river the musk of the crocodile was so strong it perfumed the whole air. We embarked at sunset in Courschied Bey's cangia, and rowed down to Ibrahim Capitaun's establishment for boat-building, an hour lower down the river. He received us with much kindness and hospitality, and in the morning showed us his works. He has four Arabs, a Copt, and a Turkish soldier with him, and about forty slaves, which, considering the near approaches of the Shelooks, and the uncertain fidelity of so many blacks, whose interest it would be to join the attackers, makes his situation by no means agreeable during the summer season. In the Khareef, also, all share alike in the danger of the climate—yet Ibrahim Capitaun, with abilities to build solid boats, has remained in this sickly country seven years. He came with Ismael Pacha, for a pay of three hundred piastres a month—twenty dollars—and this is not regularly paid. He wishes to return, and has asked me to forward his request to the consul. The boats are built of acacia, a wood extremely durable, but so hard that when seasoned a nail will scarcely penetrate it. The iron comes from Odessa, by way of Cairo. In Kordofan iron is found on the surface, but has never been examined by scientific persons. Every year ten large boats are built, with the timbers and frames of ten more stowed within them. Ibrahim says that he saves the Pacha three hundred purses a year by these boats—an incredible sum.

April 1.—We bade our host adieu, and have had an agreeable day's row down the Bahr-el-Abiad. The banks are like the most beautiful wood and lawn views of the Thames, but without houses. Towards evening the shores were more bare. Saw several hippopotami.

IV.—*Notes on Upper California.* Communicated by Dr. Thomas Coulter. Read 9th March, 1835.

Upper California is usually considered as extending from the coast of the Pacific to the Rio Colorado, and from the boundary with Lower California, a few leagues south of San Diego, to the parallel of 42½° N., which is supposed to run through the middle of the lake Timpanogos (though, with respect to this latter circumstance, I am by no means satisfied, being much inclined to think that Timpanogos, which I believe to be the same as that called by the hunters Black Lake, is wholly within the Mexican territory). But the course of the Rio Colorado is entirely within the Rocky Mountains, which are separated from the inhabited, and indeed habitable, portion of California by a great sand plain, destitute of water. This plain is about 100 miles in breadth at its southern extremity, and about 200 at the northern; about 700 miles in length, gradually ascending toward the north, and similar in every respect to that on the eastern side of the Rocky Mountains; and we shall have a much better idea of the country by considering it therefore as bounded to the eastward by this plain.

Our view is thus confined, then, to a narrow tract of country of very remarkable features, the general run of its mountain-ridges, continuous with the chain of Lower California, being nearly parallel with the coast, and almost all the minor streams running north-westerly. Of the great rivers falling into the Bay of San Francisco, through the Boca de Carquinas, the Sacramento only has a southern course. The Jesus Maria and the San Joaquin run westerly or north-westerly, as do all the others collected in the Tule Lakes before entering the bay.

This view of the country is somewhat different from that usually entertained, and I am sorry that I am not able to speak to the whole of it on my own authority, not having been to the north of San Francisco, nor east of the Tule Lakes. It is necessary here, however, to notice the great popular error respecting these lakes. The great object of the earlier Spanish expeditions, under Columbus and his immediate followers, was not the discovery of a new continent, but of a western passage to the islands of the Pacific and to China; and even after a great extent of the coasts of America had been explored, the discovery of this passage continued to be a favourite object, everything that encouraged the hope of its attainment being greedily laid hold of. Hence the endless accounts of deep inlets and inland seas; and the extent to which the imagination was engaged in these may be judged of by the reception given to the fabulous story of a passage said to have been actually made from the north-west coast into Hudson's Bay. This anxiety, then, to find a passage from sea to sea, and the facility some of the earlier travellers had in *creating* what they wished to find, where there was no immediate risk of detection, raised these comparatively insignificant ponds to the rank of a vast inland sea. The Tule Lakes are now known not to exceed 100 miles in total length, being fordable in the dry season in several places; and notwithstanding their many tributaries from the eastward, they discharge, during a considerable portion of the year, very little, if any, water into San Francisco. It is only immediately after the rainy season, which is usually ended by February, and during the thaw of the snow on the high range of hills between the lakes and great sand plain, that there is any considerable discharge of water from them in this direction. Such at least is the account given by the American hunters. A severe accident prevented my crossing this ground myself in company with a party of beaver-trappers; but I afterwards met with their chief, a very intelligent man, from whose account, compared with that of one of the missionary priests who had visited the Gentile Indians (*gentiles*) on the borders of the lakes, I have ventured to lay them down; and though there must of course be still some uncertainty respecting them, I hope further observation, whilst it must correct, will confirm the general view I have taken of the country. Limited, as I have supposed, to the eastward by the sand plain, the general form of the country is somewhat triangular, the ridge of mountains from Lower California dividing into several others, which slightly diverge as they advance northward. The great snowy peak of San Bernardino, east of San Gabriel, being the point from which the two principal ranges start; the one, the great snowy chain, separates the sand plain from the Tule Lakes; and the other separates the Tule Lakes from the seabord, not running farther north than San Francisco. Several minor ridges extend between this latter and the coast, of which the principal is that running from Monterey towards Santa Barbara, separating the Rio San Buenáventura, or the Monterey River, from the coast, and uniting with the Tule chain about Santa Ynes. The islands of the Channel of Santa Barbara also seem like the summits of a submarine chain, having its general direction parallel to the others.

It will not be necessary to enter, at present, into much detail of my journeys in the country, of which the principal was that from Monterey to the junction of the Rios Colorado and Gila; but I think it requisite to state the means used for determining the positions laid down in longitude. I had a transit in Monterey; but though set up there, the weather was too unfavourable to allow me to depend much upon the results; which, however, is of the less consequence, as that point has been carefully laid down by Captain Beechey. I have, therefore, assumed the longitude of Monterey as he gives it, and taken departures from it eastward by chronometer.

The only point at which I thought it necessary to take lunar distances was the ford on the Rio Colorado, six miles below its junction with the Gila, and that only as a check on my chronometer; for having been their reduced to one serviceable one, I felt it proper to take some precaution lest any accident should happen to it on my return, and so deprive me of the advantage of the returning set of observations for time. I however got it safely back to Monterey, and as I found the differences of meridian made going and returning, as shown by the chronometer only, to correspond very closely, I trusted to it *solely*.

I am the more disposed to insist particularly upon this point, because doubts have been expressed of the possibility of using a chronometer on shore, from the difficulty of transporting it safely, particularly on horseback. I am satisfied, from repeated trials, that this difficulty is not so great as has been imagined. All that appears to be necessary, is to carry the chronometer belted tight against the abdomen, and wear it so day and night. The march of that carried on this voyage affords one proof out of several I could state of what can in this way be accomplished, even under very unfavourable circumstances. The subjoined tables show the rate it kept, and the mode adopted of checking it at different points of the journey. It will be seen by these that time was taken, both going and returning, at several points, and that, had any derangement occurred, it must have been detected.

Observations in the order of their dates.

				m.	s.
Jan. 22.	Monterey.	Chron. by M. T.	+	22	45·6
Feb 22.	„	„	+	18	54·3
Mar. 20.	„	„	+	16	06·9
April 6.	Santa Barbara	„	+	5	09·1
„ 23.	San Gabriel	„	—	2	54·5
„ 30.	La Pala	„	—	7	35·4
May 8.	Ford	„	—	17	48·8
„ 17.	„	„	—	18	59·7
„ 27.	La Pala	„	—	10	40·5
June 15.	San Gabriel	„	—	8	50·3
July 5.	Santa Barbara	„	—	4	39·8
„ 7.	„	„	—	4	54·9
„ 19.	Monterey	„	+	2	33·4
Aug. 2.	„	„	+	1	07·1

Same observations arranged in sets for rate.

				m.	s.			m.	s.	
Monterey.	Jan. 22.	Chr. by M.T.	+	22	45·6					
„	Feb. 22.	„	+	18	53·4	Rate	—	7	5	daily.
„	March 20.	„	+	16	06·9	„	—	6	1	„
„	July 19.	„	+	2	33·4	„	—	6	7	„
„	Aug. 2.	„	+	1	07·1	„	—	6	16	„

				m.	s.			s.	
Santa Barbara.	Apr. 6.	Chr. by M. T.	+	5	09·1				
„	July 5.	„	—	4	39·8	Rate	—	6·56	daily.
„	„ 7.	„	—	4	54·9	„	—	6·7	„
San Gabriel.	Apr. 23.	„	—	2	54·5				
„	June 15.	„	—	8	50·3	„	—	6·7	„
La Pala.	Apr. 30.	„	—	7	35·4				
„	May 27.	„	—	10	40·5	„	—	6·8	„
Ford, on Rio Colorado.	May 8.	„	—	17	48·8				
	„ 17.	„	—	18	59·7	„	—	7·88	„

Results.

				m.	s.		m.	s.
Monterey, to Ford	diff. made	going	=	28	24·4	mean	28	31·45
	„	returning	=	28	38·5			
Monterey, to Santa Barbara	diff. made	going	=	8	59·4	mean	8	54·15
	„	returning	=	8	48·9			
Santa Barbara, to San Gabriel	diff. made	going	=	6	19·1	mean	6	15·9
	„	returning	=	6	12·7			
San Gabriel, to Ford	diff. made	going	=	13	15·5	mean	13	20·9
	„	returning	=	13	26·3			

The sum of the three latter means (28^{m} 31^{s}·95) corresponding nearly with the result of the first taken singly.

Respecting these tables, there are two circumstances which require some little explanation. One is the change of rate to the amount of about one second daily during my stay at Rio Colorado, attributable perhaps to the excessive heat to which we were there subjected, the thermometer, exposed to the radiation of the plain only, standing frequently at 140° Fahr. (Further on there will be found some remarks on the causes of this very high temperature, so unusual in an extra-tropical latitude, with some other observations on the climate of Mexico which may be interesting to the reader.) Perhaps this degree of heat ought not to affect the chronometer; but I found it so intolerable, that I was obliged to leave off the belt in which I carried it, and to allow it to lie horizontally during my stay, which may also have contributed to produce the disturbance. The effect of this change is got entirely over by making account only of the time by chronometer at my arrival and again on my departing, leaving out of account the ten days during which I remained stationary.

The other circumstance deserving note is the difference observable in the easting and westing in some of the *divisions* of the journey, whilst there is none on the *whole*. This is not very great, and may be partly accounted for by the want of a barometer, which, from having frequently broken tubes before, I did not carry on this journey, which I was obliged to make very rapidly. I was consequently obliged to correct the refraction by guess. Whatever error there may have been in my guess would manifestly act in opposite ways, going and returning, and its effect be got rid of by taking the mean of the results, the only evil being the discredit it appears to throw on the chronometer.*

I have laid down the junction of the Rios Colorado and Gila nearly forty miles farther north than Lieutenant Hardy has done, and this also it is necessary to explain. This point, which was the site of the two missions of San Pedro and San Pablo, has long attracted a good deal of attention. Ever since the unsuccessful attempts of the Jesuits, particularly Padre Kino, to establish a communication over-land between Sonora and California, this point, near which is the best, and indeed usually the only practicable ford on the river below the junction, has been especially looked to. After Upper California was partially settled, the two missions abovementioned were established, and at first throve well; but in consequence of the removal of the commander in charge of them, in whom the Indians had great confidence, the neophytes rose, destroyed and abandoned the mission. The remains of that on the north side are still visible; it was built on a point of rock projecting a little into the river, and constituting the extreme southern point of the Rocky Mountains, towards which the river has gradually cut its way, leaving behind a broad plain now pretty well covered with poplar and brushwood. The junction of the two rivers is not a mile above this point, the Colorado coming south and the Gila nearly west.

When Lieutenant Hardy found himself on the point of the island of Algodones, forty miles south of this, nothing was more easy, unacquainted as he was with the country on either side, than that he should suppose himself at the junction of the two rivers. The two channels of the Colorado at this point run, with respect to each other, exactly as the two rivers do; and if he had known anything of the missions and the point of hill on which one of them was built, he had in view, on his north, a knoll, the only one in the plain, but very remarkable, and close to the river, which would much assist in leading him astray.

It would occupy too much time to go at present into any great detail of my travelling inland. I am tempted, however, to say a few words of the journey of which the principal observations are

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* I subjoin also a short table of the chronometrical measurements between Mexico and Zimapan, made in precisely similar circumstances. The chronometer was made by Crossthwaite (1361).

					h.	*m.*	*s.*
Zimapan, ...	April	8th, A.M.	8 h.	Chr. by M. T.	1	8	40·7
”	”	15th, P.M.	4	”	1	6	31·3
Mexico,	”	22d, P.M.	4	”	1	6	43·2
”	”	29th, A.M.	7½	”	1	5	10
R. D. Monte,	May	1st, P.M.	3½	”	1	6	32·2
”	”	14th, A.M.	8½	”	1	3	4·3

given above, as it was the most interesting, the longest, and by far the most laborious of those I made in California.

The rainy season of 1832 ended late in February, which is rather after the usual time, and I started so soon as the country was passable, which it is not at all during the rains, nor for some time afterwards. The rivers, which in the dry season are mere beds of sand, are quite impassable when swollen; and even for some weeks after they have fallen low, the danger and difficulty of crossing some of them, on horseback, are very considerable. If these streams carried down only sand, they might be passed as soon as the rapidity of the current was so far abated that a horse could stand; but the sand comes down mixed with a vast quantity of mud, which settles together with it; so that even when the stream becomes so low that a small animal can walk across, a horse or a man cannot. It is not until the mud is gradually washed out of the surface of the deposit that this becomes possible. We have then a bed of hard sand resting upon one of semi-fluid mud and sand; and it is very difficult to say when and where it is safe to attempt the passage. On this occasion I had to pass the Guadalupe, in this state, between San Luis Obispo and La Puríssima; and it was only after long search that I found a place where a bear had passed, and trusting to his sagacity I followed his steps. The stream was broad, very shallow, and the bed of clear sand on the surface of the deposit must have been very thin, for it swagged under foot like the surface of a quagmire. A body of troops which passed this way some days before, though on a most urgent affair, was obliged to wait for ten days to allow the sand to settle.

From Monterey southward the road runs through a series of narrow ravines, as far as San Luis Obispo; but about Santa Ynez, south of San Luis, and again in the neighbourhood of Santa Barbara, it runs on, or close by the beach; whence, southward, it keeps chiefly along the west foot of the mountains, separated from the sea by low sand-hills, in some places of considerable breadth, as at San Gabriel, where they are almost twelve leagues broad. The best way to the Colorado, in the dry season, is to follow the coast road as far as San Luis Rey, and thence ascend the Pala stream, which runs in a very narrow ravine behind the maritime ridge, crossing the summit level between its head and that of the small stream of San Felipe, which runs south-eastward till it reaches the border of the sand plain at Carizal, where it sinks; though its course across the plain, when swollen, which it rarely is, is marked by a dry channel, in many points of which a little water, usually very bad, is to be had by deep digging.

There is not much difficulty in any part of the journey up to this point,—the Carizal; but from hence across the plain, which is here about one hundred miles broad, and totally destitute of pasture, cattle suffer extremely. It is always possible to carry water enough for a party of men; but horses and mules must pass the first two days absolutely without water or food,—and even then get only brine at the point called the Aqua Sola, from its being the only pond on the plain. When I passed, the water I found at this place was so strong that it purged both men and cattle. There is here some rush and reed which mules will eat, though horses usually refuse them.

From hence there is still another day's journey to the Rio Colorado. After passing the river the same difficulties continue for seven days farther, on the Sonora road, as far as Alta; but this part of the journey, from its greater length, it is extremely imprudent to attempt without a proper guide. The only water to be had is found in the ravines, frequently at some distance from the road, in excavations called Tinajas, made by the Indians, who were formerly much more numerous in this neighbourhood than they are at present.

The only settled portion of Upper California lies along the coast; the missions being nearly all within one day's journey from it. The only point where a mission has any settlement farther inland is at San Gabriel, where the Rancho of San Bernardino is at the head of the valley, some thirty leagues from the port of San Pedro. This is indeed the only point of either Californias, south of San Francisco, capable of sustaining a large population. The valley is above thirty leagues long, and of considerable breadth to the westward, where it approaches the coast, and joins on either side the plain of San Fernando and San Luis Rey. It is in many places very fertile, and wheat, where it can be irrigated, yields better here than in any other part of the Mexican territories that I have seen. The vine also thrives better, and is beginning to be extensively cultivated. The mission alone has above a hundred and twenty thousand vines immediately about it; and the inhabitants of the Pueblo have many fine vineyards. Here there is room for a great increase of population. The want of a safe port is indeed a great inconvenience; but I have no doubt that it will be got over, and that we shall see the Pueblo rise rapidly to the rank of a considerable town. The anchorage of San Pedro, though very unsafe in bad weather, need be used but for the moment vessels are taking cargo on board or discharging; and, the time they are salting hides, or are otherwise detained, may be passed in perfect safety at the island of Catalina, in front; which, besides two rather exposed anchorages to the east and south, with good water at this latter, has a very beautiful little bay on the west side, perfectly land-locked, where might be the salting-houses. The present government does not allow this, from fear of smuggling, and not without some reason. San Diego, moreover, where the chief part of the salting is now performed, is not distant.

I have gone thus far into this subject because the general government is now making considerable efforts to colonise Upper California from Mexico, under the apprehension that, if not done, the North Americans will get in in too great numbers. This apprehension appears to be hardly rational, as the *tierras realengas*, or lands still at the disposal of the state, are in California, as they always have been in the Spanish colonies, given gratis, at the discretion of government, and not sold to the best bidder, as in the United States. Any efforts made for the purpose of colonising Upper California should be directed towards the portion of the country north and east of San Francisco and east of the Tule lakes, which is fertile, well wooded and watered, and of sufficient extent to make its colonisation worth while as a speculation; the rest of the country south of San Francisco and west of the Tule lakes, possessing, with the exception of the valley of San Gabriel, too little cultivable ground, and of this a very small portion irrigable—the soil, however, where it is arable, being usually rich. Wheat, the vine, and all fruit trees that have been tried, thrive remarkably well, though the mildew near the coast, about Monterey, frequently hurts the wheat; and the chapul, or locust, by which name a great variety of grasshoppers is known, often destroys the vine, and indeed everything else. A mild winter is sure to be followed by this pest, particularly south of Santa Barbara. They appear to breed along the coast in the sand-hills; and as the north-westerly winds prevail, they are carried inland, and destroy everything they meet.

The great article of produce in Upper California is black-cattle, and their increase has been really prodigious. It is not yet seventy years since their first introduction, to the number of twenty-three head. In 1827 the missions possessed 210,000 branded cattle, and it was supposed not less than 100,000 unbranded. It is found necessary to slaughter not less than 60,000 annually, to keep the stock down to its present standard, which it is supposed it could not much exceed with advantage, until more of the country to the eastward shall have been settled. The young cows usually bear a calf before they are two years old, which, with the rule usually observed, not to kill a cow capable of bearing, will account for their rapid increase. Sheep have increased nearly as rapidly, but are as yet of little interest to the trade of the country. I have not heard of any export of wool from California. Sheep are rarely slaughtered for consumption, as their price has been kept up by the priests, either without any definite motive, or what is, I fear, more near the truth, from some mistaken calculation. It is sufficiently strange that where the fattest bullock is worth only eight dollars, and can rarely be sold at all, and where young cows in calf can be bought in droves at about two dollars, and frequently less, a sheep cannot be bought for less than three dollars. This state of things of course cannot last long. The destruction of the missions now in progress will throw into the market a stock of about 200,000 head, which of course must soon fall to its proper value.

The number of the white inhabitants has also increased very rapidly, and I believe is now not under six thousand, though I cannot state their numbers very exactly until I shall have examined the statistical materials which I have collected.

The reverse, however, is the case with the aboriginal inhabitants. They have diminished considerably in number, though, in this case, one would suppose they ought at least not to have lost ground, not having been driven from their homes, as in the United States, nor having had ardent spirits at all within their reach until lately. But they have been compelled to live under a restraint they could not bear, and to labour a little—neither of which they would submit to if they could possibly avoid it. Though the fact is as far as possible dissembled, I believe that a great deal both of force and fraud were used in congregating them together in missions; and the moment that force shall be altogether withdrawn, I have no doubt that the majority of them will return to the woods. Now that the seabord is pretty much occupied by whites, the Indians will probably retire to their relations still living free in the interior.

It is a very extraordinary fact that their decrease is greatly hastened by the failure of female offspring,—or the much greater number of deaths amongst the females in early youth than among the males,—I have not been able clearly to determine which, though the latter appears the more probable; the fact, however, of there being a much smaller number of women living than of men, is certain. Infanticide, properly so called, is not common, though very frequent recourse is had to the means of producing abortion, chiefly mechanically; but this will not account for the state of things described. as males and females must be supposed in this way to suffer equally. All the missions of Lower California have perished or are perishing from this cause, or at least with this accompanying circumstance: and in Upper California, in almost all the missions, a great many of the men cannot find wives. The mission of San Luis Rey is the only remarkable exception. In it the Indians are stated to be upon the increase, and the women in numbers equal to the men; but my acquaintance with this mission is too limited to enable me to speak of the causes of their momentary escape from what appears to be the inevitable fate of their race in the neighbourhood of white men—a fate from which I fear the Luisenos are not likely to escape. The political reforms now in active operation in California, and of which the first and most important measure is the destruction of the missions, will enable the white inhabitants to acquire possession of the great bulk of the mission lands; and though agreeably to the spirit of the Spanish laws, which certainly were meant to afford the Indians a degree of protection unknown in our old colonies, they may for a long time retain a portion of their ancient possessions, it is but too probable that the combination of their own vices to which they cling, with those of their intruding neighbours, which they very easily acquire, will ensure the ultimate annihilation of a race which exhibits so few traces of moral energy.

I shall not at present go into any examination of the vegetation of California, though this, as well as its Fauna, is well worthy of the most attentive consideration. But I am tempted to make a few observations on some circumstances in the general aspect of the country, which appear sufficiently striking. The accompanying map, though very rude, and in many respects certainly not very correct, will serve at least to show that we must consider the whole of the two Californias as one great chain of mountains, with several long but usually narrow valleys dividing it into ridges nearly parallel with the coast, and as a whole, separated by the gulf of Cortez and the great sand-plain, from Sonora and the Rocky Mountains; with which latter, however, the Californian chain appears ultimately to unite north of the parallel of 42°, about the great summit-level dividing the waters of the Columbia from those falling into the bay of San Francisco. The neighbourhood of this bay is the only part of the country likely ever to become of much interest to Europeans. It is highly fertile, well wooded, watered, and perfectly healthy. The Sacramento is navigable to a considerable distance, and runs through a country capable of sustaining an immense population. Even the Tule lakes, though navigable for steam-boats only when flooded, will then afford the means of transport for timber, hides, and other produce, from a considerable and valuable tract of country.

Lower California is pretty rich in minerals. I have seen very rich argentiferous lead ores from the southern extremity of it, and gold is also found in several places. But in Upper California, I know of no place where either has been found, except to the eastward of Santa Ynez, where a small silver mine was successfully wrought for some time, till the owners were killed by the Indians; and in one of the streams falling into the southern Tule lake some gold has also been found by the beaver hunters, but as yet in very small quantity.

I shall conclude this paper with a few remarks upon the climate of Mexico. In an early part of my letter I stated that the thermometer had frequently stood at 140° Fahr. This, it is necessary to explain, was the temperature of the atmosphere a few feet above a plain excessively dry and heated by the sun; and something may also be due to the circumstance of the thermometer, although carefully screened from the sun, being exposed to the radiation of the soil, which was very great and frequently oppressive. This very high temperature is not, however, to be considered as of very frequent occurrence, but always owing to some local and temporary causes; one of which, and indeed a necessary condition for its attaining its greatest height, being that there should not be any wind. Such was the case during the latter three days of my stay at the ford on Red River. The wind, after having blown for many days from the S.W., suddenly lulled three days before my departure on my return, and continued dead calm for the first day of my journey, that is, until reaching Agua Sola. This was one of the most painful days I have spent, notwithstanding that the excessive dryness of the atmosphere necessarily exempted me from that oppression felt in damp situations even at very inferior temperatures. To this extreme dryness must also be attributed the occurrence of severe cold occasionally in the same situations.

The surface of the country, covered in almost its whole extent with bare mountains or sand plains, completely destitute of water, contributes nothing towards mitigating the cold of the winds blowing from the elevated portions of the Rocky Mountains to the N. and N.E. Hence, when these continue to blow for any length of time, it freezes even to the south of Pitis, in lat. N. 29°; and in the winter of 1829-30, it froze in Pitis every night for nearly two months. On the 12th December, on arriving at San Jose, a few leagues from Pitis, I found the thermometer at 18° Fahr., at 8 h. P.M. On the 13th, it stood in the shade below 32° all the day, at night sinking even to 18°. This, however, appears to occur very rarely. I understood that for seventy-two years there had not been a frost severe enough to kill the mesquites (a species of acacias), which on this occasion suffered severely.

Though it is not exactly in point, I cannot avoid noting, that, on the table-lands of Mexico, similar cases of cold occur, with the difference of being more frequent, as may be easily conceived from its greater elevation, with the same condition as to the general scarcity of water. At Veta Grande, Zacatecas, during the month of December, 1825, it frequently froze hard. I subjoin some extracts from my journal.

	Max.	Min.
December 2	53°·5	20°
" 3	48°·5	18°
" 4	34°	18°
" 6	59°	41°
" 12	—	12°

and so on through the remainder of that month and January ensuing.

This was not stated to be unusually severe. It is strange that the agars and many species of cactus should be able to resist this cold. They do not indeed thrive, but they live, only of course in consequence of the extreme dryness of the ground at that season.”

A few years before, the water, trickling down the sides of the shaft of Concepcion, froze to the depth of seventy varas (thirty fathom). The shaft is in a very sheltered situation, but as its mouth is far below the level of the general drainage shaft, close by it, the cold air enters by Concepcion, and after circulating through the working, issues warmed through the tiro general as through a chimney.

The condition of countries situate as a portion of Sonora and California is, between the summer and the winter rains, is worthy of some consideration. Having seen only this one, I shall limit my observations to it.

The whole of the rain in Mexico may be said to fall in the summer months; occasional and usually slight showers fall in winter, but are pretty much limited to particular districts, as Xalapa, &c. In California Alta, on the contrary, it rains only in the winter, with a similar exception in favour of Monterey, where there are sometimes, but rarely, slight showers in summer. The summer rains reach the lower part of Sonora, where, however, they are scanty and irregular; and from Pitis, northward, across the sands, it rarely rains at all; as is also the case in the northern portions of Lower California, where the summer rains scarcely prevail to the north of Loretto, the capital.

I am sorry to be obliged to content myself with offering the Society so desultory and imperfect a sketch as this; but I have many claims on my time, the most urgent of which is the preparation of a work in some detail on the entire subject of California. Whatever is here defective will there, I hope, be found supplied.

V.—*On the General Outline and Physical Configuration of the Bolivian Andes; with Observations on the Line of Perpetual Snow upon the Andes, between 15° and 20° South Latitude.* By J. B. Pentland, Esq. Communicated by Woodbine Parish, Esq. Read March 23, 1835.*

Baron Humboldt, in the interesting notes to the third volume of his “Relation Historique,” has so accurately sketched the general outline of the Peruvian Andes, situated between the four-

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* This paper was written in 1830, and was intended as an introduction to a geological description of that part of the Andes of Peru.

teenth and twentieth parallels of south latitude, as to render it unnecessary for me to enter into any detail respecting the physical configuration of that portion of the chain. I shall only therefore observe, for the information of those who may not have perused Baron Humboldt's work, and by way of confirming his description by what has fallen under my own notice, that the great chain of Andes, which appears to form a single and undivided ridge from the most southern extremity of the American continent to the neighbourhood of the tropic of Capricorn, separates into two great longitudinal ridges in the vicinity of the celebrated city of Potosi (lat. 19° 35′). These ridges, which, viewed on a large scale, may be said to be parallel to each other, bound the immense inter-alpine valley of Desaguadero, including the great mediterranean Lake of Titicaca, the islands and shores of which may be considered the birth-place of Peruvian civilization; and re-unite at the northern extremity of this great basin, to form again an undivided ridge in the Andes of Vilcañota and Cusco. The westernmost of the longitudinal ridges above-mentioned runs parallel with the shores of the Pacific Ocean, and is distinguished in the Alto-Peruvian provinces by the denomination of Cordillera of the Coast; whilst the eastern ridge, or that of the interior, is known by the general name of Cordillera, and in its northern prolongation, of Cordillera Real. I mention these local designations of the two great divisions of the Andes of Bolivia, as in the course of this paper I may have occasion to employ them, for the sake of brevity or otherwise.

In a mountain system, formed on the gigantic scale of the Andes, it is difficult to fix the geographical position of each bifurcation, and consequently to state with accuracy the exact parallel of latitude where the Cordillera separates into the two longitudinal ridges of the Bolivian Andes. Yet the western ridge, or Cordillera of the Coast, may be said to detach itself from that of the interior, in lat. 20° S., in the mountains of Lipez and Chichas; and the road from Attacamá (lat. 23° 22′), and from the port of Cobija (lat. 22° 23′), to Oruro (lat. 17° 58′) and La Paz (lat. 16° 30′), crosses the western Cordillera near its southern extremity, where some snowy peaks rise upon it, the elevation of which can fall little below 18,000 British feet.* At the period of my journey (1827) little was known of the topography of this part of the chain, owing to the aridity and uninhabited state of the countries bordering on it; but since then, the establishment of Cobija as a free port, and now the great emporium of the foreign trade to the Bolivian provinces, and the consequent constant communications from thence with the interior, have rendered the examination of this portion of the Andes more easy, though still it is but very little known to the naturalist and geographer.

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* The principal nevados of this part of the chain, and which are known to the inhabitants of the interior of Bolivia by the names of nevados of Esmoraca and Lipez, rise considerably above the limit of perpetual snow.

I shall now, however, proceed to notice different parts of each of these two Cordilleras, founded on my own observations. Between the parallels of 19° 20′ and 18°, the western Cordillera attains a very great elevation, and offers several snow-capped peaks, well known to navigators who sail from Cobija to Arica. The most southern group of these peaks consists of four majestic nevados, known to the aboriginal inhabitants of the neighbouring provinces of the interior by the names of Gualatieri or Sehama, Chungara, Parinacota, and Anaclache; and may be seen from the valley of the Desaguadero on the one side, and from the shores of the Pacific on the other, towering over the port of Iquique (lat. 20° 13′). The nevado of Gualatieri or Sehama, which appeared to me to be the most elevated of the four, rises from an extensive table-land of new red sandstone, above the alpine village of Cosapa, in the Bolivian province of Carangas—five leagues distant from Turco—in the form of one of the most regular truncated cones I have seen in the Andes, enveloped to its base in perpetual snow. Masses of ashes and of vapour are seen to issue from its summit at intervals, so as to leave no doubt of its being a volcano in activity. From a trigonometrical measurement, executed at a considerable distance from this cone, its highest point appeared to me elevated 4800 feet above the snow line in the month of March; and as I have elsewhere shown that this line seldom descends lower than 17,100 feet in this parallel in South America, we may reasonably conclude that the volcano of Gualatieri rises to an absolute elevation of 22,000 feet.

North of Gualatieri are seen to rise two magnificent nevados, which, owing to their similarity of form and their contiguity to each other, are known to the Creole inhabitants by the name of Melizzos or Twins, whilst they are called Chungara and Parinacota by the Indian population. The most southern of these two nevados forms a very perfect truncated cone, whilst the most northern rather resembles a dome or bell (campana). There is little doubt that both are of igneous origin; and judging from the similarity of its shape to that of other active volcanic vents in the Andes, and also from its position, there is every reason to believe that the volcano of Chungara possesses an extensive crater at its summit, and is still in activity, although I was unable to discover, from the Indians who inhabit the neighbourhood in the summer season, that it had been seen to emit either ashes or vapour. The bell-shaped configuration of Parinacota, on the other hand, renders it probable, that like Chimboraço and the nevado of Chuquibamba (of which I shall hereafter speak), it has been formed by one great trachytic elevation. The nevado of Anaclache is certainly less elevated than any of the three preceding, and did not appear to me to exceed 18,500 feet. It forms a ragged ridge of considerable length in the direction of the axis of the Cordillera, and, like similar mountains in the vicinity of Arequipa, appeared to me to be also of trachytic origin.

Continuing to follow the western Cordillera in a northerly direction, we discovered several snow-capped peaks between the parallels of 18° 51′ and 17° 30′ S.; and the centre of this group may be fixed near the Indian hamlet of Tacora (lat. 17° 50′), and the Guatillas Pass, a col or passage of the western Cordillera, which attains a elevation of 14,830 feet, where it is crossed by the great commercial road leading from the port of Arica to La Paz, and the interior of Bolivia. The nevados seen from the roads of Arica, and from Tacna, belong to this group. The nevado of Chipicani[*] (at the south-western base of which the hamlet of Tacora is situated) consists of a broken-down crater, with an active solfatara in its interior, emitting quantities of aqueous and acid vapours, which by their condensation give rise to the Rio Azufrado, a considerable torrent that derives its name from the large quantity of sulphates of iron and of alumina which its waters contain in solution. The nevado of Chipicani rises to an elevation of 16,998 feet, which may be considered as the mean height of the snow-capped mountains that belong to this group of nevados.

I regret not having in my possession any precise data on the configuration or elevation of the western Cordillera, between the parallels of Ancomarca (lat. 17° 32′) and of Arequipa (lat. 16° 24′). Between the city of Moquegua (lat. 17° 42′), situated on its westerly declivity, and the village of Santiago de Machaca, on its eastern, the Cordillera of the Coast is traversed by a road that leads from the maritime province of Moquegua into the interior of Bolivia, along which are transported the brandies, cottons, and other articles which the districts bordering on the ocean furnish to the inhabitants of the Alto-Peruvian provinces of La Paz, Oruro, and Potosi. An elevated cone-shaped nevado is discovered from several points between Puno (15° 50′ S.) and the village of Desaquadero, (16° 38′ S.,) situated on the declivity of the western Cordillera, towards the basin of the lake Titicaca, and in a south-west direction. The clouded state of the atmosphere in the season of the rains, when I visited this part of Peru, only permitted me to obtain a few transient glimpses of it, and I was consequently unable to observe its exact bearings, angles of elevation, &c.; it appeared to me, however, to enter far beyond the limit of perpetual snow.*

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[*] In the interesting description of his journey from Arica to Puno, Dr. Meyen has applied this name to a peak, still belonging to the same group of nevados, different from that here described. The mountain of Chipicani of Meyen is situated near the post-house of Ancomarca (lat. 17° 32′ S.), the torrent of Utchosoma which flows past this, having its source in the snow or glaciers on its south-eastern declivity. In this arid region of the Andes, where there scarcely exists any fixed population, the nomade aborigines met by the traveller frequently apply the same appellation to different peaks, and *vice versâ*; so that it is impossible to arrive at the true Indian name of each remarkable eminence: hence the difference between Dr. Meyen's and my statements as regards the nevado of Chipicani. And I may here state once for all, that the same doubt attaches to the names given to many other mountains mentioned in this paper.—Vide *Meyen Reise um die Erde*, vol. i.

In 16° 24′ S., towering over the populous city of Arequipa, the capital of southern Peru, rise three snow-capped mountains, nearly of equal height, viz. Pichu-Pichu, the volcano of Arequipa or Guagua-Putina, and Chacani. The first and third of these mountains form two elongated serrated ridges,† whilst the second presents a very regular volcanic cone, truncated at its summit, and rising to an elevation of 18,300 feet above the level of the Pacific. This volcano has a deep crater, from which ashes and vapour are constantly seen to issue. The three nevados of Arequipa, like most of the mountains of igneous origin in the western Cordillera, are placed near its maritime declivity; but about ten leagues from the same point, in a S.E. direction, and consequently farther removed from the borders of the sea, is situated the volcano of Uvinas, now extinct, but which, in the sixteenth century, produced an eruption, that spread desolation and aridity for many leagues around. The volcano of Uvinas has since ceased to burn, and at present offers a very extensive though shallow crater, where the aborigines of the surrounding country collect small masses of alum, which they use as a mordent in dying their coarse woollen tissues. The volcano of Arequipa, and the adjoining ridges of Pichu-Pichu and Chacani, if they do not rise above the limit of perpetual snow, approach very nearly to it. When I visited Arequipa, during the spring months (October and November) of 1826, all three were deeply capped with snow; but I was assured by residents in that city, that after very warm summers the summit of the volcano is sometimes seen without a trace of its icy hood, and that the nevado of Chacani is at times deprived of its snow during the autumnal months. As to the volcano of Uvinas it little exceeds 16,000 feet in elevation.

On the prolongation of the western Cordillera, north of Arequipa, rise the nevados of Ambato, and Corpuna; and about twenty miles from the same city the colossal nevado of Chuquibamba, so called from a large village situated at its base. The nevado of Chuquibamba has the form of a dome, and when seen from the plain presents, under certain points of view, a striking resemblance to Chimboraço, as delineated in Baron Humboldt's 'Vues des Cordillères;' it appears to be formed like this latter giant of the Columbian Andes, of one simultaneously uplifted mass of trachyte, which has pierced and reposes upon the subjacent secondary strata (new red-sandstone, with saliferous and gypseous marls). The dome of Chuquibamba rises to an elevation of 21,000 feet, deduced from a measurement I made of that portion of its summit which rises above the limit of perpetual snow, assuming this latter line at 17,200, in the parallel of 16°.

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* This is probably the mountain seen by Meyen between the villages of Pisacoma and Marocollo, to which he has given the name of Volcan Viejo, and which he considers as attaining an elevation between 19,000 and 20,000 feet.

† The mountains of Pichu-Pichu and Chacani, are composed of trachytic rocks, and have probably formed a portion of the walls of a very extensive elevation crater, in the midst of which the more recent eruption cone of Guagua-Putina, the modern volcano of Arequipa, has been raised.

Between the latitude of Arequipa (16° 24′) and that of Lima (12° 3′) I have not visited any part of the Peruvian Andes, so that I am ignorant of their configuration and elevation beyond the nevado of Chuquibamba. But I have been informed by travellers that the portion of the chain which is traversed by the road from Arequipa to Cusco (lat. 13° 42′) presents numerous nevados, equalling in magnitude and elevation that of Chuquibamba.

Having thus passed in review the principal mountains of the western Cordillera, in an extent of nearly 5° of latitude, it remains for me to add a few remarks on its breadth and general configuration.

As I have already noticed, its most elevated points consist either of volcanoes still in activity or of mountains of igneous origin: they are situated, with a single exception (the extinct crater of Uvinas), close upon the maritime declivity of the Cordillera, and consequently at an inconsiderable distance, not exceeding sixty miles, from the nearest shores of the ocean. The western declivity consequently of this Cordillera is extremely precipitate and abrupt from this circumstance: so much so indeed, that the traveller in many places finds himself transported, in a few hours, from the fertile valleys bordering on the Pacific, to the arid regions of the Cordillera at an elevation exceeding 15,000 feet. On the eastern side of the Cordillera of the Coast the declivity is less rapid, since it is there skirted by a valley which itself is elevated 13,000 feet; and thus, from its loftiest passes, the descent to the valley of the Desaguadero, or to the shores of the great lake of Titicaca, does not exceed 4000 feet.

I have endeavoured to deduce the maximum breadth of the western Cordillera from my astronomical observations made on either declivity, the most modern maps being extremely defective as regards the geography of the Alto-Peruvian provinces, the position of their towns, and the delineation of the mountain chains by which they are traversed. In the parallel of 16° 24′ S. I find that the western Cordillera intercepts a space equal to 2° 1′ in longitude, that is, between the city of Arequipa and the western shores of the lake of Titicaca, not far from the large village of Juli (lat. 16° 11′). I am aware, however, that this determination on a single parallel cannot be considered as giving the real width of the chain, since its direction forms an angle with that of the Cordillera. A line passing from Arequipa to Puno (16° 24′ to 15° 50′) will perhaps represent the real breadth of this Cordillera more exactly, as being nearly perpendicular to its axis (which runs from about S.S.E. to N.N.W.); and here the intercepted space occupies an extent of 1° 32′, or about eighty-eight miles, the longitude of Arequipa being 71° 54′ and that of Puno 70° 22′ west of Greenwich. We may therefore conclude that the western Cordillera occupies in breadth a space of nearly one hundred English miles; and we shall see hereafter the immense breadth which the two Cordilleras united occupy.

The Eastern Cordillera, which may be called also the Bolivian, since the greater part of its extent is comprised within the political limits of the Republic of Bolivia,* detaches itself as a separate chain in the 20 par. of lat. south of Porco (19° 50′) and of Potosi (19° 35′). The metalliferous mountains which surround the former town may be considered as constituting its southern extremity; and the celebrated mountain or cerro of Potosi also belongs to it. The mean elevation of this metalliferous group does not exceed 16,000 feet, which is nearly that of the mountain of Potosi (16,040 feet); none of its peaks consequently rise within the limits of perpetual snow.

Between the parallels of Potosi (lat. 19° 35′) and that of 16° 50′ no part of the Bolivian Cordillera attains an elevation of 17,000 feet, none being enveloped in snow during the entire year, until it reaches the latitude of 16° 40′,† where the gigantic mass of Illimani suddenly rises, forming the southern extremity of the great Bolivian snowy range. Between Potosi and Illimani the Eastern Cordillera presents numerous passes or cols, some of which equal in height those of the Western Cordillera.‡

The nevado of Illimani § is situated in lat. 16° 40′. Its form is that of a serrated ridge, elongated in the direction of the axis of the chain upon which it rises, offering four principal peaks to the observer, when seen from its western side. From the city of La Paz (lat. 16° 30') distant about thirty miles, it presents itself with the imposing grandeur of Montblanc when seen from Sallanches, or of Monte Rosa from the subjacent valley of Macugnaga.

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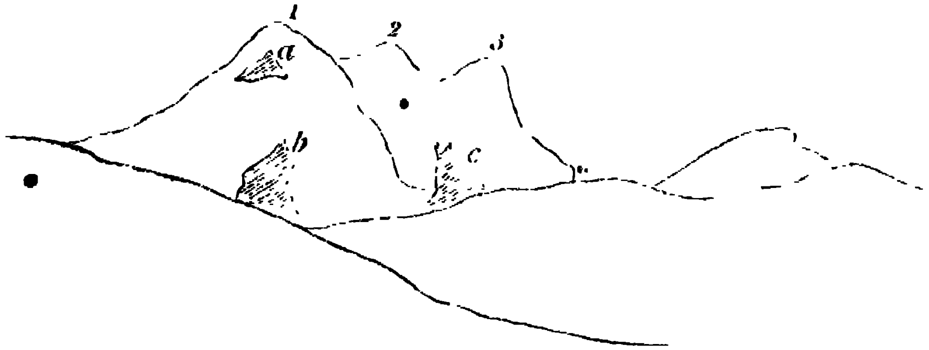
* The Republic of Bolivia, founded in 1825, embraces those provinces of Alto-Peru which, under the dominion of Spain, formed the Presidency or Audiencia of Charcas,—viz. La Paz, Oruro, Cochabamba, La Plata or Chuquisaca, Santa Cruz de la Sierra, with the Missions of Moxos and Chiquitos, Potosi, and Tarija.

† This position has been deduced from bearings observed at La Paz and La Ventilla, on the road to Potosi, the geographical situation of which had been previously ascertained by direct astronomical observations.

‡ The most remarkable of these passes, are that of Livichuco, which is traversed by the road from Oruro to Chuquisaca; and that of Challa between Oruro and Cochabamba.

§ Illimani, or Yllimani, appears to derive its name from its icy covering, *Illi*, in the Ymarra dialect of the aborigines, signifying snow.



[Outline of Illimani, seen from the valley of La Paz.[*]]

The elevation of this giant of the Bolivian Cordillera is 24,200 feet, and the lowest glaciers on its northern declivity, the only part of it I could visit, do not descend below 16,500.

North of Illimani, but separated from it by the deep valley of Totoropampa and Totoral, which forms one of the most frequented communications between La Paz and the province of Yungas, celebrated for its rich plantations of coca (*Erythroxylon coca*), is situated the Nevado of Tres Cruces, towering over the Indian hamlet of Totoropampa; and from this point (lat. 16° 35') the Bolivian Cordillera may be said to form an almost continuous line of snowy mountains, to its junction with the Western Cordillera in the Andes of Vilcañota.[†] It is to this portion of the Andes that appears to have been more particularly applied the denomination of Cordillera Real, doubtless from its great elevation, its imposing grandeur, and the considerable extent in which it is discovered from the subjacent (comparatively) low country. From the shores of the lake of Titicaca the Bolivian Cordillera presents an almost continuous line of nevados from Illimani on the south, to those of San Juan del Oro, and of Vilcañota on the north. The most elevated pinnacles of this snow-capped range tower over the large Indian village of Sorata, in the province of Larecaja, and hence are known among the Creole inhabitants by the name of Nevado di Sorata, and by the aboirgines, who use the Ymarra idiom, by the several names of Ancomani, Itampu, and Illhampu; the most elevated attains the immense height of 25,250 feet, being situated in lat. 16° 10′, as deduced from bearings taken from the shores of the lake of Titicaca. And although, as just observed, the Bolivian Cordillera, north of Illimani, may be considered as one continuous line of snowy peaks, there are some which deserve to be cited from their especial elevation, as, for example, the Nevado de Cacaca, north of La Paz; the Nevado de Mezada, so called from its flat summit resembling a table; and north of the gigantic Nevado of Sorata, that which towers over the Indian village of Yani. I possess no positive data on the Bolivian Cordillera beyond the point where it is traversed, in a most remarkable manner, between the villages of Ananea and Consata (16°), by the river Mapiri, one of the largest affluents of the great river Beni; but it appears certain, as already noticed, that it continues to form an almost continued line of Nevados, until its junction with the Western Cordillera in the Andes of San Juan del Oro, and of Vilcañota.

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[*] In this outline the 4th peak is not visible, being hidden by the northern (1); the part of the mountain embraced is entirely enveloped in snow, except the patches *a*, *b*, *c*, formed by prominent masses of rock.

[†] The view of this portion of the Bolivian Cordilleras is particularly magnificent from one of the islands in the lake of Titicaca (Isla de Coata, lat. 16° 3'), from which the whole snowy ridge is seen, with the immense expanse of the subjacent lake in the foreground.

When seen from its western declivity, the Bolivian Cordillera offers a succession of sharp, ragged peaks, and serrated ridges; a configuration which contrasts with the conical and bell-shaped summits of the Cordillera of the coast, and results from their different geological composition.

I have already stated, that the greater number of the passes or cols by which the Eastern Cordillera is traversed, south of the parallel of Illimani, are situated at elevations exceeding 14,000 feet. In this portion of the chain no part of it indeed descends to my knowledge below this level; and the rivers, consequently, that rise on its western side empty themselves into the Desaguadero. Arrived, however, at the snowy portion of the range, things become completely changed, and the torrents which there descend from either declivity of it empty themselves invariably into the affluents of the Amazon, those on the west side crossing the chain of the Bolivian Cordillera; whence it arises that the snowy Cordillera is traversed north of 16° 50′ of latitude by many deep valleys, and offers many passes at elevations greatly inferior to what might at first view be expected from the excessive mean elevation of its highest summits. This very curious fact of rivers escaping through such an immense mountain-mass as the Bolivian Cordillera is perhaps one of the most important points connected with the physical geography of this portion of the Andes, and deserves to be noticed at greater length.

The annexed map of this portion of the Andes, destined to show the affluents of the Rio Beni which have their source in the department of La Paz, has been reduced from several MS. maps made by the missionaries which I have consulted, as well as from my own observations; and will render clear the remarkable geographical fact to which I have above alluded.

It will be seen, that all the rivers descending from the western side of the snowy Cordillera empty themselves into two great channels, the Rio Mapiri on the north, and the Rio Chuqueapo, or river of La Paz, on the south. The Mapiri, a very considerable stream, traverses the central ridge of the Bolivian Cordillera north of the Nevado of Yani, between the villages of Ananea and Consata; and, after a very tortuous course, joins the rivers Tipuani, Challana, and Coroico, which descend from the eastern declivity of the same Cordillera, and form by their junction the Rio Caca. The Rio Chuqueapo * rises among the glaciers that cover the nevados north of La Paz; whence it passes through that city, and, running parallel to the Bolivian Cordillera receives all the rivers that descend from its western declivity as far south as 16° 55′, the point where it runs through the chain to enter the province of Yungas, constituting one of the highest branches of the great river Beni; and thus it may be considered, not only the source of this latter, but also of the Madeira and Amazon, if we adopt as the source of these great rivers the affluent the most distant from their mouths. I have not been able to ascertain the exact elevation of the two remarkable gorges or chasms through which the Mapiri and Chuqueapo traverse the chain; but from the nature of the vegetation on the banks of the latter at this point (*Bananas, Grenadillas,* &c.), it does not probably exceed 6000 feet; and thus we have a valley 18,000 feet lower than the neighbouring peaks (those of Illimani), which almost overhang it, perhaps the greatest difference that has been observed in the level of the most elevated points, and of the adjoining valleys of any mountain system yet examined.

The declivity of the Bolivian Cordillera is rapid on either side, but particularly so on the eastern. On the western it presents short transverse valleys, which only in its southern portion open into the great basin of the Desaguadero. On the eastern side it sends off many lateral and transverse ridges, which, for the sake of brevity, I shall designate with Baron Humboldt by the name of the Contrefort of Cochabamba. The mass of hilly or mountainous country which forms the whole of the Bolivian provinces of Cochabamba, and of Chuquisaca, and a part of those of Potosi and of Santa Cruz de la Sierra, consists of lateral or transverse ridges, which the Bolivian Cordillera sends off from its eastern side, and which only terminate in the extensive plains of Chiquitos and Paraguay. The most remarkable, for extent and elevation, of these transverse ridges, is that which bounds on the north the rich valley in which the city of Cochabamba (lat. 17° 23′) is situated; and which, detaching itself from the Cordillera nearly in lat. 17° 10′ south, rises above the limit of perpetual snow, near Cochabamba, in the pointed Nevado di Tinaira; whence it becomes gradually lower, forming the territory of the Yuracarâes Indians, and finally terminating on, or near, the banks of the Rio Guapäi or Grande, within a few leagues of the town of Santa Cruz de la Sierra.

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* *Chuqueapo,* the name of La Paz in the Ymaira dialect of the aborigines, signifies field of gold. The word Chuque is frequently met with in names of places in the Bolivian Cordillera, Chuque-camata, Chuque-saca, &c.

† I am aware that this point may be disputed by those accustomed to pin their faith to the erroneous compilations of Olmedilla de la Cruz, the Padre Sobreviela, and their copyists; but I possess the proof that the Rio Beni (which with the Mamore and Ytenes form the Madeira) is formed by the union of two great streams, the Mapiri or Caca on the north, and the Chuqueapo on the south, both of which rise on the west declivity of the Bolivian Cordillera, and unite the waters of that majestic chain in its highest portion between 16° 55′ and 15° 40′.

Having thus sketched the great mountain-features of the Bolivian territory, it remains for me to say a few words on the extensive inter-alpine valley that separates the two Cordilleras, embracing the Valley of the Desaguadero and the celebrated Lake of Titicaca, thus forming one continuous basin. The limits of this great mountain depression are the parallel of Lampa in 15° 5′ on the north, and that of Condorcondo in 19° 30′ on the south. Its width varies considerably in its different parts. In the parallel of Puno (lat. 15° 50′) it exceeds sixty miles, and in lat. 16° 50′ it is still wider; but from this point to its southern termination it gradually narrows, so as in the parallel of Oruro (17° 58′) not to exceed thirty-five miles. From a calculation which I have made, the superficial extent of this immense basin, including that occupied by the lake, exceeds 16,000 square miles (geographical), and the lake at the present day covers between a fourth and fifth of that area. I say at the present day, for it appears that its extent has diminished even within the historical period of this continent; since a writer,* soon after the conquest of Peru by the Spaniards, describing the gigantic Peruvian monuments of Tiaguanaco (lat. 16° 34′), says, that the waters of the lake washed their walls, whereas these ruins are now elevated many feet above the level of the lake, and are at a considerable distance from it. I shall have occasion, however, elsewhere to enter on this subject more at length.

The valley of the Desaguadero is necessarily in the direction of the two chains that inclose it. In its southern portion it runs nearly parallel to the meridian; but north of lat. 17° it forms an angle of almost 35° with that line, running very nearly north-west by north and south-east by south. It is entirely bounded by mountains, having no outlet towards the sea; and the rivers which descend into it are either lost in the sandy soil, or empty themselves into the lake of Titicaca at its northern extremity. This celebrated lake, the most extensive fresh water accumulation in the South American continent, occupies an area of almost 4000 geographical square miles, and forms the northern extremity of the great inter-alpine depression in the Bolivian Cordilleras. From a very extensive and accurate series of barometrical observations made on its shores, its waters in the dry or winter season are situated 12,795 British feet above those of the Pacific Ocean, an elevation superior to that of the highest summits of the Pyrenees. Owing to the total want of boats at the period of my journey, other than the rude canoes of the natives, I was not enabled to obtain deeper soundings than 120 fathoms; but from the precipitous cliffs which in many parts of it form the shores, and its islands, I am persuaded that its depth in the central portion is considerably greater The lake of Titicaca receives numerous streams at its northern extremity, but by no means so great a mass of water as might be expected from the height of the Andes that surround it; arising from the *divortia aquarum* of the Western Cordillera* being situated little distant from the shores of the lake, so that the greater part of its waters run towards the Pacific, while on its eastern side the lake is bordered by a low secondary ridge of red sandstone, which prevents the torrents descending from the Eastern Cordillera reaching it, and causes them to form the Mapiri and Chuquecapo, running to the Amazon. The principal streams that supply the lake of Titicaca are those which on its northern side form the rivers of Asangaro, descending from the Cordillera of Crucero and San Juan del Oro, and that of Lagunillas, which rises in a chain of small lakes in the Western Cordillera. Its only outlet is the River Desaguadero, which issues from its south-western extremity in lat. 16° 38′ 10″ south, and is an inconsiderable stream when compared to the immense extent of the lake from which it issues; † an anomaly which may be easily explained by the great amount of spontaneous evaporation to which its surface is exposed in an extremely dry and rarefied atmosphere, owing to its excessive elevation.

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* Garcilaso de la Vega, *Commentarios Reales.*

The lake of Titicaca contains numerous small islands; that from which it has taken its name, and which is situated at the south-east extremity, being the largest and most celebrated, tradition having there placed the miraculous appearance of Manco-Capac, the first Inca of the last Peruvian dynasty of sovereigns, where he laid the foundation of those extraordinary theocratico-political institutions which enabled his successors to found the most extensive empire in the annals of American history, and to bring about a degree of civilization among their subjects so superior to that of the other barbarous nations of the American world, as to enable the Peruvian Incas in the twelfth generation of their dynasty to extend their conquests from Cundinamarca, and the equinoctial regions of Quito, to the centre of Chili. The island of Titicaca still contains numerous Peruvian ruins, of which I shall speak in another place.

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* I found the width of the river Desaguadero, in the beginning of the rainy season, and close to its origin in the lake, to be forty-six yards; its course was scarcely two miles an hour, but its depth considerable.

† Most map-makers have placed the Bolivian Cordillera to the west of the sources of the Mapiri and Chuqueapo, acting no doubt on the old notion that none but great mountain-chains form *divortia aquarum;* and thus, in the best maps of Peru, the sources of the Mapiri, Beni, and the towns of Sorata, La Paz, are placed on the eastern declivity of the Bolivian Cordillera, whilst they are really situated on the western side of that ridge.

To complete the description of the mountains of Bolivia, it is necessary to say a few words on a system of elevations which exists between the two great Cordilleras, connecting them in some degree, and crossing the great inter-alpine depression which I have just described. This chain detaches itself from the western Cordillera in lat. 16° 38′, where the river Desaguadero emerges from the lake of Titicaca,* and flows in a gorge through this intermediate chain, which, for the sake of brevity, I shall call that of Pacajes, from the province of which it constitutes the greater part. It thence runs in a south-east direction, passing near the far-famed Peruvian ruins of Tiaguanaco (lat. 16° 34′), to Corocoro and Belen, lat. 17° 18′, near which it ceases to form a continuous chain, being succeeded by a series of insulated conical groups, which form the mining districts of Laurani, La Silla, and Oruro (lat. 17° 58′), each of these groups rising like so many islands in the midst of the great plain of the Desaguadero. South of the metalliferous group of Oruro is situated the mountain of Poopo, separated by a valley, through which the river of Sorasora runs to empty itself into the Desaguadero; and this mountain of Poopo is directly connected with the eastern or Bolivian Cordillera. The direction of the chain of Pacajes is nearly north-west by west, no part of it reaching the region of perpetual snow, the most elevated point I have visited being situated between Corocoro and La Paz, where a conical mountain, formed of highly inclined strata of the new red sandstone series, rises to an elevation of 15,100 feet. We may, therefore, consider the intermediate chain of Pacajes as forming a kind of connecting link between the two great Cordilleras, although raised perhaps at a later period; a view which is confirmed by its geological structure.

In concluding this article, it may not be uninteresting to inquire what may be the mean breadth of the Andean chain within the geographical limits here contemplated—*i.e.* between the fourteenth and twentieth parallels of south latitude, where this gigantic range attains a greater transversal development than in any other part of its course. As the incorrect maps hitherto published of this country can afford no data to arrive at even an approximative result, I shall be obliged to employ my own astronomical observations, which are unfortunately too few to fix with certainty this important point of the physical geography of South America. In the parallel of 16° 30′ the direction of the chain of the Andes is inclined about 35° to the meridian; and here I determined, at the maritime base of the Western Cordillera, the longitude of Arequipa, 71° 54′, and on the eastern base of the Bolivian Cordillera, that of Chullumani, situated near the foot of Illimani, 67° 40′; the intercepted space being, consequently, 4° 14′, or 243½ miles. On the parallel of 17° 25′ to 18°, I determined the longitude of Tacna at the west base of the Cordillera of the coast, and of the city of Cochabamba on the east foot of the Bolivian Cordillera, 70° 12′, and 65° 52′, the direction of the Cordilleras on this parallel being inclined about 20° to the meridian; the intercepted longitude is, consequently, 4° 20′, or 228½ miles. Finally, in the parallels of 19° and 20°, I determined the longitude of Tarapaca and Chuquisaca, 69° 27′, 64° 26′ (lat. 20° 6′ and 19° 3′), the direction of the Cordillera being the same as in the parallel of 17° 18′, so that the intercepted line is nearly at right angles with the axis of the chain, and the distance 284 miles. Reducing, then, these different distances to lines forming right angles with the direction of the chain in the different parallels, we shall obtain for its breadth

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* From the erroneous drawing of every map of Peru hitherto published, the Desaguadero is represented as flowing into the lake of Titicaca, whilst the contrary is the case; an error caused by map-makers being at a loss to dispose of its waters otherwise, and being ignorant that they are dissipated by spontaneous evaporation.

Between 16° and 17° South latitude, geographical miles	199·5
„ 17° and 18°	214·5
„ 18° and 19°	266·0
„ 19° and 20°	266·0

The above numbers express the breadth of the Andes, taken from the extreme base of each of the central chains only, or of the two Cordilleras, with the intermediate valley of the Desaguadero; and, as I have already stated, it will be found much greater than that of any other part of the chain. But if, instead of taking the breadth of the two principal ridges, we adopt, for the width of the chain, the extreme points of the lateral ridges which rise from either side of the Andes, we shall find that in the parallels of 17° 25′, in which the town of Santa Cruz de la Sierra, at the eastern extremity of the Contrefort of Cochabamba is situated,—the mountainous ridges which rise from the two Cordilleras, and these two Cordilleras themselves united, occupy an extent of 8° 40′ in arc, or 500 geographical miles.

I shall conclude this notice by a few observations upon the limit of perpetual snow on the Andes comprised between the 15° and 20° of south latitude.

In a paper, inserted by M. Arago, in the 'Annuaire du Bureau des Longitudes,' for 1829, founded on notes which I communicated to him, and in a correspondence with Baron Humboldt, which appeared in the 'Hertha' for the same year, I have shown that 5200 metres, or 17,100 English feet nearly, may be assumed as the mean elevation of the inferior limit of perpetual snow in those parts of the Andes between the 14th and 20th parallels of south latitude, which I had occasion to visit during my journey in Upper Peru. And I shall now endeavour to establish this anomalous fact, anomalous in so far as it is in opposition to all preconceived opinions respecting the distribution of heat in South America, by adducing the principal examples upon which it is founded, and which I trust will suffice to render it evident to the most sceptical.

The first point I shall cite, and of which I have had occasion to speak in my preceding observations, is the volcano of Arequipa (lat. 16° 20′), which, according to my observations, attains an elevation of 18,300 feet.[*] Its apex is in general covered with snow for about 500 feet below its summit, at all seasons; but this sometimes disappears entirely during the autumnal months. The circumstance of this mountain being an active volcano may render it improper for determining the limit of perpetual snow, but as the volcanic action is of a very limited nature, confined to the emission of clouds of aqueous vapour, and perhaps of ashes at remote intervals, it cannot be supposed to exercise any great influence in modifying the temperature of the surface of the cone; besides, on the adjoining mountains of Pichu-Pichu and Chacani the snow line is on the same level as on the volcano, and disappears under the same atmospheric circumstances. We may, however, adopt 17,200 feet as the inferior limit of the perpetual snow on that mountain, and in the early part of the summer season (October and November).

In my letter to M. Arago I have also cited the mountain of Inkocajo, situated near the centre of the Western Cordillera, in lat. 15° 58′, and near the sources of the river of the same name, which passes through the city of Arequipa. Here the lowest patches of snow, and those placed only in the ravines, were 1300 feet higher than the pass of Los Altos de Toledo, or at an absolute elevation of 16,850, whilst the great mass of snow covering the summit was fully 250 feet higher up. This was in the middle of October, and consequently at the close of the spring.

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[*] There is a measurement of this mountain, by a Mr. Curzon, in Shillebeer's Voyage, who states it to be 2775 toises, or 16,650 feet.

I have only had occasion to determine the height of the snow line on a single nevado in the southern prolongation of the Western Cordillera,—viz. the extinct volcano of Chipicani, which towers over the village of Tacora (lat. 17° 50′). On the 9th of March, corresponding in the southern hemisphere to our autumn, I found the barometer at mid-day to mark 18,158 inches, th. at. (Fahr.) being at 61°·7, which gives 14,255 feet for the height of the station. From this point I measured a base line, and by means of angles taken with a good sextant and mercurial horizon I found the elevation of the snow-line to be 2500 feet higher; whilst on the northern side of the mountain, that exposed to the more continued action of the solar rays, the same line was 390 feet more elevated than on its south declivity; adopting, therefore, a mean of these two determinations, we shall have for the height of the inferior limit of snow, at the close of the summer, and in lat. 17° 48′, 5181 metres = 16,945 feet. It is on this determination that are partly founded the heights which I have assigned to the nevados of Gualatieri, Sehama, Parinacota, &c., the elevation of the summits of which I had only occasion to determine above the snow-line. The nevado of Chipicani is situated in lat. 17° 48′, as results from bearings carried on from Ancomarca and Palca, the latitude of both which places was deduced from good meridian altitudes of *α Lyræ*.

On the Eastern Cordillera I shall cite two direct observations only, made on the gigantic Illimani, and on the south-east declivity of the neighbouring nevado de Tres Cruces. At the former station, close to the lowest patch of snow I could discover, and my observation was made in the month of December, the barometer stood at 16,477 inches th. at. (Fahr.) 49°·3, which, compared with the mean of my observations made at the same hour, and at La Paz during several successive days (19,507 inches, Fahr. 62°·6), gives 16,865 feet, for the height of my station.

In speaking of Illimani, I have stated that its lowest glaciers, or snow collected in the ravines, did not descend below 16,340 feet. The lake of Illimani is itself placed at an elevation of 15,950 feet, and although at the time I visited it a good deal of rain had fallen in the subjacent valleys, and that snow lay in the more elevated situations, not a particle of either snow or ice was to be seen within 350 feet of its level.

The nevado de Tres Cruces rises at a short distance from the northern base of Illimani, and is only separated from it by the deep valley of Totoral and Totoropampa; here I reached the snow-line during the same journey, and found my barometer to mark 16,347 inches, Fahr. 41°·5, whence the elevation of my station was 17,090 feet.

South of the 18th parallel of latitude I have not been able to determine the inferior limit of the snow-line on any mountain, the season having prevented my examining the numerous nevados of the provinces of Carangas, Atacama, and Lipez. The only snowy mountain south of this parallel, where I am aware that any observations have been made, is the nevado of Chorolque, in lat. 21° 30′, not far from Tupisa (lat. 21° 28′), the capital of the Bolivian province of Cinti; and on which Dr. Redhead, a gentleman well versed in meteorological studies, writes to me that the snow-line descends, in the month of March, as low as 15,120 feet. I entertain very great doubts, however, as to the accuracy of this observation, since, in the mountains of Porco, and on the Cerro of Potosi (lat. 19° 50′ and 19° 36′), not a particle of snow was to be seen in the month of December, and these mountains attain an elevation of 16,000 feet; it is difficult, therefore, to suppose a sudden depression of nearly 900 feet in the limit of perpetual snow, in an extent so trifling as eighty or ninety miles. Besides this, Dr. Redhead estimates the total elevation of Chorolque at only 16,548 feet—an altitude too small, evidently, since the whole of the snowy portion of the pyramid of Chorolque is visible from Bartolo, a village north-east of Potosi, itself elevated 11,100 feet, and distant, in a straight line, from Chorolque at least 115 geographical miles.

Recapitulating, therefore, the preceding observations, we shall obtain for the mean elevation of the inferior limit of perpetual snow—

On the Volcano of Arequipa,	lat. 16° 20′	Elev. 17,200 feet.
Nevado of Inkocajo	15 58	,, 16,850
,, Chipicani	17 48	,, 16,946
,, Illimani	16 42	,, 16,865
,, Tres Cruces	16 30	,, 17,090
Mean elevation of the snow-line		16,990

In corroboration of this important fact, that the inferior limit of perpetual snow is here much higher than in the prolongation of the chain in the same latitude in the northern hemisphere, and even than in its equatorial regions, I shall cite some points, the most elevated I have had occasion to visit, where not a particle of permanent snow was to be seen:—

1. Cerro di Potosi, the summit of the celebrated metalliferous mountain, in lat. 19° 36′; its elevation being 16,037 feet.

2. Mountain of Porco, lat. 19° 45′; elevation 15,913 feet.

3. Mountain of La Galofa, on the northern declivity of Illimani, lat. 16° 42′; elevation 16,250 feet.

[These three localities present elevations superior to that of the inferior limit of the snow-line under the equator, which descends to 15,748 feet; and the mountains of Potosi and Porco attain, within a few feet, the level of the highest peak of Pichincha (the Rucu Pichincha), elevation 15,925 feet, which is covered at all seasons with its icy coating.]

4.	Passage of Chullunquani,	lat. 17° 18′	Elev.	15,610	feet.
5.	„ Las Gualillas	17 50	„	14,830	
6.	„ Los Altos di Toledo	16 2	„	15,528	
7.	„ Paquani	16 33	„	15,226	
8.	„ Leñas	19 16	„	14,203	
9.	„ La Compuerta, or Lagunillas	15 52	„	15,613	

Of these six passes, four exceed the height of the inferior limit of perpetual snow on the Mexican prolongation of the Andes, which Baron Humboldt fixes at 4600 metres = 15,092 feet. And as no fact is better calculated to convey an idea of the height of the Peruvian Andes than the excessive elevation of its mountain-passes—for it is evident that man will always seek the least elevated and dangerous passages in his migrations—I annex a list of the different passes most remarkable for their elevation :—

Western Cordillera.

1.	Altos de los Huessos, at the foot of the volcano of Arequipa	lat. 16° 21′	Elev.	13,573	feet.
2.	Altos de Toledo . . .	16 2	„	15,528	
3.	Pass of Lagunillas (the Divortia Aquarum) . . .	15 22	„	15,613	
4.	Pass of Las Gualillas . .	17 50	„	14,830	
5.	„ Las Gualillas (another) .	17 43	„	14,200	
6.	„ Chullunquani . .	17 18	„	15,610	
			Mean	14,892	

Eastern Cordillera.

7.	Pass of Pacuani .	lat. 16 33	Elev.	15,226	
8.	„ Challa . . .	17 40	„	14,700	
9.	„ Tolapalca . .	19 0	„	14,075	
10.	„ Leñas . . .	19 45	„	14,210	
11.	„ Condur Pacheta .	18 0	„	13,950	
12.	Pass between the mountain of Potosi and of Huayna Potosi	19 36	„	14,370	
			Mean	14,422	

At first sight it would appear from this list, that the depressions or passes in the Western Cordillera are more elevated than in the Eastern (which would be the contrary of the highest peaks) ; but it is to be remarked, that the passes in the former have been chosen in the most elevated portion of the ridge, their mean position corresponding to lat. 16° 52′ S. ; whereas, with the exception of No. 7, all the passes of the Bolivian Cordillera are situated in that portion of its extent where no part of it reaches 17,500 feet ; and are in latitudes more removed from the equator, viz., in a mean latitude of 18° 26′. One of the highest passes in the Bolivian Cordillera is that crossed by the road from Sorata to the great auriferous valley of Tipuani, at the foot of the nevado of Sorata. I have not been able to ascertain its exact elevation, but from the almost total absence of vegetation, and the intense cold which reigns upon it, in the warmest seasons, I am induced to believe that it falls little short of 16,000 feet.

If we compare the passes of the Andes of Bolivia with points situated in the same latitude in their northern prolongation, we shall find, that in Mexico two of the most remarkable nevados —the Iztacihuatl, lat. 19° 10′ N., 15,700 feet, and the nevado de Toluca, 19° 12′ N., 15,160 feet—although enveloped in perpetual snow, are inferior in elevation to some of the Peruvian passes. And as to the passes in the Andes of Equatorial America, we shall also find that they are surpassed by those cited in this paper; the most elevated being, according to Baron Humboldt,—

El Paramo d'Assuay	12,385	Between lat. 0° and 2° S.
Alto de Sunigaicu	14,472	
Illaino d'Altareuchu	14,425	
Ladera di Cadlud	15,527	
Los Paredones	13,263	
Paramo de Guamani	10,906	
Passage of Quindiu	11,500	
Passage of Las Guanacas	14,705	
Paramo d'Almosadero	12,850	

Finally—Baron Humboldt has given a comparative view of the elevation of the highest peaks, and the mean height of the chain of the Himalaya, Equatorial Andes, and Alps; which I shall copy here, in order to introduce that of the two Cordilleras, which I have examined.

		Highest Peaks.	Mean Elevation of the Chain.
Himalaya		25,700 ft.	15,670 ft.
Andes, between 5° N. and 2° S.		21,420	11,380
„ Eastern Cordillera,	lat. 15° 19′ S.	24,200 *	15,250
„ „	17 20 S.	17,000	14,500
„ Western Cordillera	15 19 S.	22,000	14,900
Alps of Europe		15,666	7,353

The most elevated passes of the Andes, with which I am acquainted, north of the portion of the chain which forms the more immediate object of this Paper, and the heights of which have been determined by M. Rivero, are—

Alto di Jacaibamba, road from Lima to Pasco	15,135 feet.
Alto de Lachagual „ „ „	15,480
Portachuelo di Tucto, road from Tarma to Lima	15,760 feet.
And the mountains of Guancabelica, according to Ulloa,	15,080

Unfortunately, we do not possess a single measurement of any of the very elevated nevados situated between the Chimboraço,

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* I have not considered here the most elevated part of the Eastern Cordillera, which embraces the nevado of Sorata, not knowing the *exact* elevations of any of the passes in that part of the ridge.

and 15° S. lat., some of which—those of Huaylillas, the Toldo di Neve (seen from Lima), and the nevado of La Viuda (seen from Huanuco)—attain a considerable elevation.

Between the parallels of 21° 30′ and 33° S., we do not possess a measurement of any part of the Andean chain. I have already mentioned that Dr. Redhead had determined the height of the nevado of Chorolque, situated in the former parallel; but that some doubt hangs over the determination of that observer. The Andes of Chili offer, consequently, the most unknown part of the chain.

In lat. 33° and 34°, the Chilian Cordillera is traversed by two remarkable passes—that of the Cumbre on the north, and of the Portillo on the south—between which rises the mountain of Tupungato, which towers over the capital of Chili, and which, covered at all seasons with snow, attains an elevation of 15,500 feet. The Tupungato and volcano of Penqueñes, situated near the Portillo pass, which latter rises, according to Dr. Gillies,* as high as 15,000 feet, and is covered with snow, appear to be the highest points of the Andes, between 33° and 35° S.: the most elevated passes of the same part of the chain being La Cumbre, or culminating point of the road between Mendoza and Santiago de Chili, which is 12,454 feet.† In his Paper on the volcano of Penqueñes, above referred to, Dr. Gillies furnishes us with the elevation of that volcano, 15,000 feet; and of two passes at its base, on either side of the longitudinal valley of Tunyan (a kind of diminutive basin of the Desaguadero), elevated 14,365 and 13,210 feet. South of this point numerous passes cross the Chilian Andes—that of Las Damas, north of an active volcano, probably the Descabezado, and the pass Del Planchon (less elevated than the Cumbre and Portillo, since vegetation extends to its summit), and which serves as a constant communication between the Indian territory in the Buenos-Ayrean province of Mendoza and the Chilian towns of Talca, San Fernando, and Curico. From these measurements of the passes, we may conclude that the mean elevation of the Andes diminishes very gradually, as far south as the 35th parallel of latitude.

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* Vide Edinburgh Journal of Nat. and Geog. Science, Aug. 1830.

† To arrive at this determination, I have employed the barometrical observations of Dr. Gillies, and have re calculated those of Miers and Bauza, applying corrections which these authors had neglected, and connecting their observations with others made at Santiago and Mendoza.

VI.—*On the Southern Affluents of the River Amazons:—*

1. *Translation from a MS.* (1799) *on the Advantages to be derived from the Navigation of the Rivers which flow from the Cordilleras of Peru into the Marañon or Amazons.*
2. *An Official Report* (1827) *on the River Beni, and the Countries through which it flows.* Communicated by Woodbine Parish, Esq., F.R.S. Read, 13th April.

[THADEUS HÄENKE, the writer of the first of these papers, was a member of the Academy of Sciences of Prague and Vienna. He accompanied Malespina on his voyage to the Pacific, and was afterwards sent by the King of Spain with a special commission to Peru, to examine into the mines of that country, and to introduce improvements in the mode of working them. Delighted with the province of Cochabamba, he settled there, and devoted himself for many years to the acquirement of a knowledge of that part of America and of its natural productions. He had prepared a valuable work on those countries, which would have been published many years ago, but for the revolution, which cut off his communications with Europe. He has since died in Bolivia, and it is feared that this work has been lost. Some of his papers, however, have been preserved, and amongst them his official reports addressed to the Spanish Government, of which this is one; and a second, giving some account of the province of Cochabamba, has been published in Azara's work. Others also are in the hands of individuals, who it is to be hoped will, in due time, give them publicity; for all that he wrote on Peru was valuable.

The second paper is, in the original, accompanied with a map of the Beni; but as the information furnished by this is incorporated with the other materials used in the annexed illustration of the general geography of this country, (and which will shortly be published more detailed and on a greater scale,) it is not specifically copied. It was drawn up, for the use of the Prefect of La Paz, by Francisco Herrera (Commisario Prefecto de Misiones); and is dated from Guanay, 10th Feb., 1827.—W. P.]

1. The provinces of Peru in the actual occupation of the Spaniards form but a small part of the continent of South America; generally speaking, they may be defined as a long narrow strip running along the coast of the Pacific, and bounded by the mountain-chain of the Andes: a vast territory, it is true, but nothing when considered in its relative proportion to the extreme width of the continent.

The precipitous height of the snowy mountains of the Andes on their eastern declivity—the almost impracticability of the passes—and the immense forests, hundreds of leagues in extent, reaching, indeed, it is hardly known where, are obstacles alone sufficient to have deterred not only the Spaniards, but the Peruvians before them, from making much further satisfactory progress in the examination and peopling of these vast regions; but if to these be added the dangers apprehended from the barbarous nations which inhabit them,—the almost insufferable heats,—the annoyance of the innumerable venomous insects and reptiles, and the many deep and impassable rivers; it ceases to be matter of much astonishment that the conquerors of Peru should have made such small advances beyond the ranges of the Cordilleras. It is doubtless to be ascribed to these causes, operating, it must be confessed, upon a remarkable falling-off in that spirit of discovery and conquest which animated them of old, that both the Spaniards and Portuguese have been satisfied to remain in such ignorance of immense countries within their own possessions.

The Gran-Chaco (or Great Desert); the countries between Paraguay and Chiquitos; those reaching from Moxos and Apolobamba, to the rivers Amazons and Huallaga; and from the Purus to the Ucayale, are regions almost totally unknown; not to speak of those to the north of the Amazons between the Orinoco and the Cordilleras of Quito, and Santa Fé de Bogota; and very many more.

Wherever the interior of these extensive regions has been penetrated, it has been by some of those mighty rivers which, descending from the Cordilleras, have burst, as it were, a natural path through the otherwise impassable and almost boundless forests below.

The names of Chiquitos, Moxos, and Apolobamba, might still have been unheard of, but for the rivers Paraguay, Grande, and Beni, which showed the way to them, and carried their first discoverers to those remote parts, inaccessible to them from any other direction. It is in those provinces that the Spaniards have made their farthest advances into the interior of this continent; but it was not from the coasts of Peru, and proceeding in an easterly direction that they reached them. They were originally made known by adventurers from the south, who discovered them, after toiling up the long and arduous passage of the river Paraguay. It was many years before the communication with them from Upper Peru was opened by the navigation of the Beni, and the Marmoré, and their affluents; and much later that the Portuguese, on their side, coming down from Brazil, not so much to form new settlements in them as to check the further advances of the Spaniards, determined there also to establish their line of military positions.

These provinces, in common with all those situated to the east of the Andes, however rich their lands, and precious their productions, would seem destined to labour under the greatest possible natural disadvantage, in being shut in by that tremendous barrier, the Andes—a barrier, unrivalled not only in the height of its mountains, but in the extent of its ranges; one, which Nature herself seems to have created for the especial purpose of cutting off their communications with the nations to the westward; of which, it may be truly said, as of the ocean, by Horace,—

> "Deus abscidit
> Prudens oceano dissociabili
> Terras."

The difficulties with which the nations eastward of the Andes have to contend in the transport of their productions across the Cordillera double their cost in conveying them only to the provinces of Upper Peru; and if this be the case between countries apparently bordering on each other, what must be the labour and expenses of their further carriage to those ports upon the Pacific from whence they are to be shipped for Spain!

The productions of Chiquitos and Moxos are transported more than 200 leagues to Lima, over a double range of the Andes; if they are to be sent to Europe by way of Buenos Ayres, the distance, not to speak of the difficulties of the mountainous roads of Jujuy, cannot be calculated at less than 600 leagues. Nothing but gold, and silver, and precious stones, can repay the enormous expenses of transport on beasts of burthen over such immense distances.

It is not to be wondered at that, with such impediments before them, the inhabitants should relax in their industry, and look with indifference upon the cultivation of the most precious of their productions, contented to raise a bare sufficiency for their own domestic wants, with the consciousness of being able to supply the world.

But the truth is, these impediments and disadvantages, however apparently great and discouraging, are not without a remedy,—the evil should be referred to its true source,—the false and unnatural system on which the intercourse between Europe and those countries has been hitherto carried on. By changing that system, and by opening a new channel for their exports, every obstacle would vanish; the inhabitants of those regions would be stimulated to exertion, and to the cultivation of their fruitful possessions, and Europe would reap immense benefits.

Nature, indeed, has framed her works on this continent on a gigantic scale; where else is to be found a mountain-chain like the Cordilleras of the Andes? where rivers like the Amazons and La Plata? where such extensive plains; such interminable forests? But the same hand which has raised the most wondrous and impassable barriers, in appearance, to the progress of man, in these vast regions, has not omitted to provide safe and convenient means of communication with their remotest parts, and for the interchange of their varied productions. The innumerable rivers which pour down from the Cordilleras, for the most part navigable, are but so many highways which Nature herself has opened through rocks and mountains and impenetrable forests, for the safe and convenient passage of man, and for the transport of the fruits of his industry.

Of these, one of the principal, if it be not the queen of the rivers of the world, is the Amazons, or Marañon,—in truth it may be called a sea of fresh water, which, without exaggeration, from its junction with the ocean, may be traced for upwards of a thousand leagues across this continent, communicating with all the provinces of Peru, as far as 18° S. lat., by means of the many navigable branches which flow into it: it is particularly of these rivers, which from their sources in the mountain-chains of Peru descend into the countries to the eastward, and finally fall into the Marañon or Amazons, that I propose in this paper to give some account.

In proceeding eastward from the celebrated pass or pongo of Manseriche, on the Marañon, the first river we meet with is the Huallaga; its source may be traced to the neighbourhood of Lima, not far from those of the Marañon itself, in 11° south latitude. One of its main branches descends from the mining district of Pasco, to the north-east of Lima, through a wide and broken gorge, to the city of Huanuco; it afterwards runs through the mountains of Chinchao and Cochero; and on my first visit to those parts, in 1790, I saw where they embark upon it at its junction with the river Chinchao; whence its course is northward through different ranges of the Andes, and through the district of Los Lamas, where it is increased by the streams which flow from the mountains of Huamalies, Moyobamba, and Chachapoyas, districts abounding in the finest quality of cascarilla. In about 7° south it runs through a passage something like that of Manseriche, but shorter; thence through a plain country till it unites with the Marañon, near the missions of La Laguna, in 5° south latitude, and more or less in about the meridian of 77° west from Paris. It was by this river that Pedro de Ursoa descended, in the year 1560, when sent by the Viceroy, the Marquis de Cariete, in search of the lake of Parima and the city of El-dorado, an expedition cut short by his being assassinated by one of his own companions. The famous missionary, Father Fritz, also passed it several times.

The next river of this class is the *Ucayale*, a river not inferior to the Marañon itself at its junction,—from which it is often held to be the true Marañon. Its origin is from the lake Chinchaicocha;

in the plains of Pombom, thirty leagues east of Lima, in 11° 30′ south latitude. The tributary streams which unite to form this magnificent river water a wonderful extent of country. I followed and crossed many of them in my journeys from Lima to Cuzco, and particularly in 1794 I had an opportunity of verifying the junctions with it of the rivers Yauli, Jauja, Mayoc, Mantaro, Canaire, Tambo, Pachachaca, Apurimac, Paucartambo, Vilcanota, tracing it as far as Cailloma in the intendency of Arequipa, and eastward to the confines of the Partido of Carabaya. After emerging from its narrow bounds in the Cordillera, it is increased by the river Perrene, and in 8° south latitude by the Pachitea; whence it runs through a labyrinth of forests, receiving many smaller streams in its progress. Its banks are peopled by various Indian tribes, whose names alone would make up a long vocabulary. Having passed through a prodigious extent of country it empties itself into the Marañon, near the Missions of San Joaquin de Omaguas, in 4° 30′ south latitude, and in about the meridian of 73° west from Paris. Below Omaguas, the Marañon receives from the same side the rivers Yavari, Yutay, Yuruta, Tefe, and Coari; they are of secondary order compared with the Huallaga and Ucayale, but are nevertheless navigated by the Indians even to the confines of Upper Peru, a voyage of months.

In the 63rd meridian (from Paris) and in 4° south latitude, the Purus, or by another name the Cuchivara, discharges itself. It is a river of the first class, and according to the accounts of the Indians not inferior to the Marañon, into which it falls. No one as yet has been able precisely to determine its origin, but I have data sufficient, I think, to fix it between the Cordillera of Vilcanota and the east of the mountains of Carabaya, from which descend many and considerable streams abounding in gold. In October, 1794, the Chuntachitos, the Machuvis, and Pacaguaras Indians, who live to the west of Apolobamba, gave me accounts of a very wide and deep river running through a flat and thickly wooded country, about ten days' journey west of the Beni, where I fell in with them. They distinctly explained to me that a vast many Indians and their families were settled along its shores, that in their language it was called Manoa, and that it was a larger river than the Beni. As no other river of this class falls into the Marañon between the Ucayale and Madera, I am led to believe that the Purus and the Manoa are the same, and that the difference in the name is merely the consequence of its passing through different nations, each of which may have given it a distinct appellation.

Further on, about fifty leagues, in 60° 30′ west longitude from Paris, and in 3° 30′ south latitude, we come to the famous river

Madera, a name which it derives from the many trunks of trees which it sweeps away in its current during the period of its inundation from November to April. Its sources may be traced along the Cordilleras of Pelechuco, Sorata, and La Paz, to the innermost parts of the Spanish possessions,—viz, to Moxos, Chiquitos, and the mountains of the Chiriguan Indians. From the immense extent of territory watered by this river and its affluents, from the safe and easy navigation of its main branches, from its comparatively near junction with the Atlantic ocean, and its being by far the most convenient channel of communication with the Marañon and the Portuguese settlements, I shall dwell the more particularly upon its description.

The interior or secondary range of the Andes, which, from the neighbourhood of Quito, runs in a direction from north-west to south-east, forms a considerable curve or sweep before it reaches the confines of the province of La Paz, in about 16° south latitude; where it changes its original inclination, turning in an easterly direction from its original parallel line with the coast, and stretching towards the centre of the continent. This alteration in the direction of the mountain-ranges produces a line of demarcation, as it were, between those rivers which, within a short distance of each other, run some to the north and others to the south, and which supply a large portion of the waters which subsequently form the two principal drains of this continent,—viz. the rivers Marañon and La Plata.

The principal rivers which form the Madera are the Beni, the Marmoré, and the Itenes—all navigable almost from their sources. Of the three, the Beni is the first, or most western branch: it is formed of an infinite number of smaller streams, which, falling into it within a short distance of each other, soon constitute a very considerable body of water. They have their sources in the mountains of Pelechuco, Suches, Sorata, Challana, Songo, La Paz, Suri, and Cochabamba. The farthest to the west is the Tuche; then follow the Aten, the Mapiri, or Sorata, and the rivers which, descending from the celebrated mines of Tipuani, from Challana, and from Coroico, afterwards unite; then the Chulumani and its confluent streams, the Tamampaya, the Solacama, the Rio de La Paz, the Suri, and the Cañamena; to the east, and last of all, is the Cotacajes.

I have been enabled, in my various journeys, to verify the sources of all these rivers. On the 22nd of September, 1794, I embarked on the Tipuani, and followed it to the Beni, under the guidance of the native Indians, as far as the Missions of Apolobamba and Moxos, and to the village of Reyes, near Isiamas and Tumupasa. This voyage took me not more than four days, from the rapidity of the currents as they descend from the Cordillera;

there are many dangerous passages, but the dexterity of the Indians in the management of their balsas (rafts) leaves the traveller nothing to fear.

Below Reyes, the Beni receives various other streams from the west, as the Tequeje, the Masisi or Cavinas, and others. From its junction with the Marmoré, in about 10° S. lat., both lose their names in that of the Madera.

This river flows in one even, uninterrupted, and majestic course through the level country, forming islands of considerable size, and its breadth in some parts exceeding a quarter of a league: it is full of fish, and is infested by numerous crocodiles, or caimans. Both shores are thickly studded with lofty forests, and are peopled by a variety of Indian tribes, with which the missionaries from Apolobamba have begun to have some communication. The eastern side is inhabited by the Cavinas, the Pacaguaras, the Bubues, the Torromanos, the Napas, and Tobatinguas; and the western by the Bulepas, and very many others.

It would be extremely easy to unite the Beni with the Marmoré by means of the river Yacuma, which rises near Reyes, and running eastward through the flat country between, falls into the Marmoré close to the town of Santa Anna. The fall of the land is so imperceptible, and so nearly on a level with the horizon, that it does not exceed twenty feet in the distance of more than sixty leagues.

The second or middle branch of the Madera is the Marmoré. It is inferior in nothing to the Beni, running from south to north through the centre of the extensive territories of the Missions of Moxos. Under the name of the Chaparé, it unites the rivers Paracti, San Mateo, Coni, Chimoré, Sacta, and Matani, rising in the mountains inhabited by the Yuracarce Indians, not far from Cochabamba: another arm of it is the river Grande, which divides the province of Cochabamba from that of Charcas, and into which fall the many streams which run from the Cordillera of Santa Cruz. It is from the junction of the Chaparé with the river Grande, in about 16° S. lat., that they take the name of the Marmoré. The people of Moxos navigate this river against the current for more than one hundred leagues, carrying the fruits of their industry from Exaltacion to the neighbourhood of Santa Cruz. I myself, in the months of October and November of 1794, passed over from the Beni to the Yacuma, and continued my voyage up the Marmoré and Rio Grande till I reached the port of Forès, near the city of Santa Cruz.

The third or most eastern branch is the Iténes, which rises in the low hills of the interior of Brazil, and of which the Portuguese have taken care as yet to give us very little account. It runs from east to west. Its waters are clearer and more translucent than those of the Beni and Marmoré, and some distance up it are found stones, which, in the low lands bordering on the Beni and Marmoré, are as scarce as diamonds. The bulk of its waters is less than that of those rivers. The fortification of Beyra, one of the most advanced posts of the Portuguese, is situated upon it, in about 12° S. lat., more or less, and in the meridian of 66° 30′ from Paris. It falls into the Marmoré much in the same latitude, but about half a degree to the westward of the said fort.

These are the three main branches of the celebrated river Madera, the most proper of all that I have spoken of, as a channel whereby to open a direct communication between Spain and all those vast and rich countries situated to the eastward of the Andes.

It is a pitiable sight to see the inhabitants of the most valuable and fertile possessions of the crown of Spain on this continent forced into the unnatural course of having to carry their productions to the shores of the Pacific Ocean; struggling, as it were, against the elements themselves in the toilsome passage up rivers which every league become more rapid and impracticable as they approach the Cordillera,—that Cordillera so fatal to the wretched Indians, enervated by the delicious climate of their own regions, and seldom provided with more clothing than a shirt to their backs to protect them against the cold and inclemency of the snows of the Andes; whilst, on the other hand, by merely following that course which nature herself points out in the opposite direction, and abandoning their vessels to the favouring currents of their own rivers, they would save thousands of miles in their communication with Europe. Condamine calculates that the passage of the Andes alone may be considered as equivalent to 1000 leagues of transport by sea.

And here I must make some observations upon the productions of these countries. Excepting the territory of Guayaquil, to the west of the Andes, it is solely in the Cordilleras and in the lands to the eastward of them that the most valuable productions of this continent are to be found. Gold, and it is the finest in the world, is found there in such abundance that I have no hesitation in saying there is scarcely a pass in the mountains where it is not to be discovered, although in some parts it may be of easier access than in others, and better known.

The cocoa of Apolobamba, of Moxos, of Yuracarees, and of all the woods which extend from thence to the shores of the Marañon, is infinitely superior to that of Guayaquil. The finest quality of cascarilla is only found on the eastern side of the Andes; of the indigo there is no end; I can say the same of the cotton and the rice. The precious balsam of copayva, the sarsaparilla, the gumelastic, and the most fragrant species of vanilla, are all produced in an extraordinary abundance in these regions. The mighty forests which line the shores of the rivers abound in the finest timber for all uses, especially for ship-building, and in trees distilling the most aromatic and medicinal gums. Amongst others, there is a species of cinnamon called by the natives the canela de clavo, which only differs in the greater thickness of the bark and its darker colour, according to its age, from that found in the East Indies, and which is as fragrant as the spice from which it takes its name (clove).

But the easier conveyance to Europe of these precious commodities would not be the only advantage of opening these new channels; by stimulating their industry and intercourse with the rest of the world, the people of these regions would become by degrees reduced to Christianity and civilization; and nations, at present unknown to us even by name, would be brought into direct communication with us. If Spain did but possess an establishment at the mouth of the Amazons, what would she not gain in distance alone?—Consider the difference between a voyage direct to Spain from the mouth of this river, which would scarcely occupy a month, and one round Cape Horn from Lima, or perhaps from Guayaquil!

The Indians are excellent sailors on their own rivers, and manage with great dexterity their canoes—vessels often of fifty or sixty feet long, and of considerable burthen; they are indefatigable on these inland voyages, which are of months' duration; they require but few hands, and no stock of provisions, subsisting themselves without difficulty on the fish they take, on the wild fruits and roots they gather on the passage, and on the monkeys and other game which they kill with their bows and arrows.

I would willingly volunteer my services to be the first to explore this new passage to Spain, and to survey these mighty rivers from their sources, provided the king's government would be pleased to furnish me with the necessary astronomical instruments, and such passports and recommendations as would enable me to pass without hindrance and annoyance the Portuguese ports on the way. Such an expedition would be at least of some use as a preliminary measure, to obtain a correct knowledge of the whole course of the Madera, and of the precautions requisite for its ordinary navigation, as well as to acquire some more general acquaintance than we as yet possess with the vast territories through which it flows, and the character and disposition of their various inhabitants and productions. The easterly winds which blow, according to Condamine, from October to May, favour the navigation against the current in sailing vessels, although it should be observed that further on in the interior the prevailing winds are more commonly either from the north or south, especially at the period of the inundations.

2. *The River Beni.*—This great River has its origin in the springs which issue from the lofty ranges north-west of Cochabamba, forming part of the snowy Cordillera visible from the city of La Paz; the other rivers, also, of which I shall have here occasion to speak, have their sources in the same range.

The Beni waters the whole of the district of Mosetenes; it skirts the province of Moxos, leaving it to the east, and pursues its course till it unites with the Marmoré, and loses its name.

The extent of territory comprised in the map is about 200 leagues, situated, according to astronomical observations, between 8° and 17° 30′ south latitude. In this range there seems to be nothing wanting to make it everything that man could desire for his abode. Here he may find every variety of hill, and vale, and plains, with abundant streams of running water. The vast and extensive levels along the banks of the rivers, but especially those which are watered by the Beni, offer the finest locality in the world for agricultural establishments, and for the maintenance of a numerous population. Its fertility may be seen in the extraordinary growth of the trees, and the innumerable plants which it spontaneously produces, affording sustenance and shelter to a prodigious variety of the animal creation. Amongst the beasts the most common are the tapir, the tiger, the leopard, six or seven sorts of monkeys, and several amphibious creatures. Amongst the feathered tribe may be enumerated the parrot, the caque (?), several kinds of turkeys, and a multitude of beautiful singing birds, easily tamed, such as the thrush, the whistler (silvador), and the maltico, as remarkable for its plumage as for the sweetness of its note.

It is not so easy to describe the many wild fruits, medicinal herbs, and aromatic gums which are to be met with here in the greatest abundance, inasmuch as they require in the first instance to be carefully examined by men of science; but there is not a doubt that such an examination of them would lead to many new and valuable discoveries amongst the vegetable productions of these regions.

The cacao is to be found wild in many places, in others it is cultivated; in either case it is superior to any brought to the city of La Paz. Tamarinds, the chirimoya (?), oranges and lemons, figs, the cotton-plant, the sugar-cane, pine-apples, and every sort of garden fruit flourish here with very little attention. The plantain also is to be found in abundance—that divine fruit, of all the productions of nature one of the most useful to man!—From it he makes flour, bread, sugar, spirits, and vinegar; whether roasted or boiled, raw or dried in the sun, it is delicious; of it may be truly said, as of the manna of old, *ad quod quisque volebat convertabatur.*

The water of the rivers is in general of very good quality, and the quantity of fish in them is inexhaustible. The chief sorts are the sabalo (a sort of carp), the suche (?), the dorado (a large species of tench), the hava (?), the corvino (a large perch), and many others. For the most part the rivers are navigable, with a gentle current in the deeper parts. On the shores of every one of them gold is to be found. The climate is so mild and salubrious that it may be said truly there is none like it on this continent; as a proof of which, in the settlement of Guanay, where I am now writing, in a population of 240 souls there has not been a single death of man, woman, or child, in two years and five months. The pastures are admirably adapted for cattle, which are, accordingly, in great numbers; but sheep do not thrive so well on account of the heat.

The Indian inhabitants of the territory are, in the first place, the *Aymaristas* and *Quechuistas,* who live about the sources of the rivers Quetoto, Bogpi, Coroico, Challana, Tipuani, Mapiri, and in the province of Apolobamba. Farther down are found the *Lecos,* the *Mosetenes,* the *Maropas,* and, lastly, the *Paraguaras* Indians; of which, the first, the *Lecos,* are confined to the lands between the Mapiri and Guanay, and are but few in number, not amounting in all to more than sixty families, Christians and infidels. They have a language of their own. In appearance they are a stout strong race, of an olive complexion, well-behaved, orderly, hard-working, happy, not quarrelsome, nor superstitious, though, like all others, they have their faults.

The *Mosetenes* Indians principally occupy the better lands along the River Beni; they are also to be found on the Quetoto, the Bogpi, and the Maniaque. Some of them are known by the appellation of Muchanis, Inicuanis, and Chimaris; but the fact is, they are all of the Mosetenes nation, and only assume those names from the particular rivers near which they reside; they also have their own separate language. They are a well-conditioned race, frank and disinterested, and very friendly with strangers, very ingenious, and evince an extraordinary sagacity in discovering the medicinal qualities of plants, which they well know also how to administer in sickness with admirable success. Like the Lecos, they are peaceably disposed, and free from superstition. They maintain themselves by their labour, and on fish and game, which they know how to catch with much dexterity. In all the settlements of the Mosetenes there may be about 140 families.

The *Maropas* Indians are commonly known by the name of Reyesanos, from their residence about Reyes, on the River Beni. This settlement of Reyes properly belongs to the province of Moxos, in which may be counted no less than thirteen different Indian tribes, each having a separate language. The Maropas were originally reduced by the Jesuits, since whose expulsion they have been considered under the superintendence of the Bishop of Santa Cruz de la Sierra. They are a warlike and proud race, but evince great ingenuity and aptness for many sorts of work; the cloths they manufacture are beautiful; they are very good carpenters; and they show a marked taste for music and painting, in which they were initiated by the Jesuit fathers.

The climate of the province of Moxos, where they reside, is very hot, and the air is infested day and night by millions of musquitoes. The water even is hot. There are several lakes in it, and it is subject to the inundations of the River Marmoré; the pastures however are excellent, and the cattle are abundant in them.

The *Pacaguaras* Indians reside on the shores of the Beni, below Reyes. They are a barbarous race, as yet unconverted. Wild and warlike, they go naked, and even the women wear nothing but a few leaves tied round the waist.

The River Beni, as has been before said, unites with the Marmoré, which takes thence the name of the Madera, and falls into the Amazons, whereby a communication is open with the Atlantic. Along the shores of these rivers it is believed that many barbarous nations reside, of whom as yet little can be said with any certainty; nor are we likely to know more of them till new expeditions of discovery are set on foot, and intelligent people shall go amongst them. The result of such undertakings would be of the greatest importance to these valuable countries, not only in tending to further the knowledge and increase of their productions, but in establishing an easy communication from them with Europe and with the rest of the world.

The best part of Peru is as yet, it may be said, unknown. The riches it contains are immense; but to secure and turn them to account will require energy and exertion, and some encouragement from our rulers.*

[* The Bolivian Government is now extending this encouragement, offering grants of land to adventurers, and considerable premiums for the establishment of steam-navigation on the rivers above described.]

VII.—*Remarks on the Voyages to the Northern Hemisphere, ascribed to the Zeni of Venice.* By Capt. C. C. Zahrtmann, R.N., Hydrographer to the Royal Danish Navy; and communicated by him. Read 27th April, 1835.

THE latest researches in Greenland strongly tend to prove the correctness of Eggers's assertion, that the coast to the eastward of Cape Farewell was never colonized by the Icelanders; but that the whole of the bishopric of Greenland must have been situated to the westward of this cape. Greater certainty than we now possess can only be obtained either by the finding of ancient manuscripts hitherto unknown to us, or by further discoveries. From the former but little can be expected, the two last centuries having produced so many distinguished individuals, who made the ancient history of the north the subject of their diligent investigation. And as to making further discoveries, there can only be a very faint hope entertained, when we contemplate the difficulties which Captain Graah had lately to overcome, and when we learn from him that the ice is continually on the increase along this coast, thereby necessitating its thin population to emigrate to the west side, where this increase of ice and decay of the monuments of antiquity are also keeping pace together.

If, then, the present time offers but little probability of further elucidation on this subject, and if any future period presents even less, the present moment is certainly the most favourable to examine all the accounts which exist of the past and present times, and to investigate the degree of credit to which each of these authorities is entitled.

The old Icelandic Sagas, bearing the stamp of their age, are very often obscure, and ambiguous, and in many instances even erroneous, owing to the want of scientific knowledge which existed when they were composed; but their authors can hardly be accused or suspected of wilful misrepresentation. The same, however, cannot be said with respect to the Sailing Directions collected by the Archbishop Walckendorph in the beginning of the sixteenth century; for, in this case, it is very possible that, in order to please this mighty prelate, the seamen of Bergen might venture to lay down directions for a navigation which, as it had been left untried for a century, was entirely unknown to them. A similar suspicion attaches to Ivar Bere's Chorography, for the authenticity of which important document we have no satisfactory evidence; and it is surely a very curious coincidence of circumstances, that the Episcopal bailiff of Bratehlid, the individual who must have been best acquainted with the country and its topography, and who himself had led the succours from the eastern part of the country to the west against the Esquimaux, that this very person should have come from Greenland to the Feröe Islands, and should there have composed this Chorography, which was to remain forgotten for a whole century after the colony had disappeared, until the Archbishop should commence collecting his information. Still it is true that this Chorography, from its being so very minute—from its concordance, in several respects, with the Sagas—and from the circumstance of its appearing to be translated from the Icelandic, is entitled to considerable credit; and as it cannot be disputed that both the Chorography and the Directions are written in a language anterior to Walckendorph's age, there can be no reason to reject their evidence, although they must be considered as less authentic than the Sagas. Certain it is, that the collection of these documents, quite contrary to the intention of Walckendorph, served more to mislead than to guide, as they gave himself and posterity the erroneous idea that the ancient colony was situated on the east coast—an idea which, after having been entertained without dispute for 275 years, has since that time continued so prevalent, that in the Memoirs of the Scandinavian Literary Society for the year 1824, the following sentence appears: "The sounds of the old Sagas must have been more intelligible to Walckendorph than they are to us; and if it was his opinion that the eastern part of the old colony in Greenland was situated on the east coast, then Eggers has been himself mistaken, and has misled others."

It is quite another thing with an account of the North, which was not drawn from its own sources, and which, perhaps for that very reason, obtained for a time so much the greater credit. I mean the voyages of the Zeni of Venice, which were published about 170 years after the time when they were said to have been performed. The great credit which was given to this publication had a very remarkable influence on the ideas which were formed of Greenland. It led Frobisher to suppose that the land about Cape Farewell was an island (the Frisland of the Zeni), and, as a natural consequence, he again supposed the Labrador coast to be the east coast of Greenland, which gave rise to this remarkable circumstance in the history of navigation, that he saw and passed the very land which he thought himself still in search of, although the countries in question—viz., Labrador and Greenland—differ from each other 20° of longitude; and all this merely because he believed in an Italian fable. This mistaken opinion got such firm footing that its erroneous nature was not detected, even although, some years afterwards, other English seamen navigated the same waters, knowing themselves to be off the coast of Labrador; and the consequence was, that, for more than two centuries, Greenland was represented on all globes and charts as intersected by an imaginary strait, called the Straits of Frobisher.

It is true that Frobisher himself says that he landed on the coast of Labrador, from which assertion the late Admiral Lövenörn, in a paper published in the "Transactions of the Danish Royal Society for 1786," was led to deduce the inference that the Strait of Frobisher was not in Greenland; but it must be kept in mind, that, in Frobisher's time, Davis's Strait was not yet discovered, and that he supposed Labrador and Greenland to be continuations of the same coast. After Davis had discovered that Greenland and Labrador were separated by a strait, the Strait of Frobisher was supposed to be a narrower entrance from the North Sea into the Bay of Baffin, and was therefore called Angustum Frobisher, in contradistinction to Fretum Davis; all which is best seen in the additions to the Ptolemaic Tables, published in 1597 at Louvain, by Cornelius Wytthoff, where the chart of these regions proves the assiduity with which the author studied the latest English voyages of those times; and that he was only led into error by a belief in the Frisland of the Zeni, which confidence he did not give to their Greenland.

When the fisheries became sources of industry which gave employment to many hundred vessels in the Northern Seas, accounts were from time to time received concerning these seas; but partly from physical circumstances, producing in those latitudes optical delusions which easily induced errors, and partly from want of scientific knowledge among the navigators of that age, the result was, that these accounts frequently tended to mislead, by creating imaginary islands, such as Enkhuisen (no doubt a corruption of Ægis-ey), Bus, &c. Still, even at that period, the Island of Frisland, as it was called, was never descried, and accordingly it had already vanished from the sea-charts even before the method of finding the longitude at sea had become generally known, and had thus enabled every seaman to ascertain his position with precision; by which means the charts have been cleared of the errors which had crept into them, and we have now a certainty, that in the Northern Ocean between Europe and America, to the south of the Arctic Circle, there exists neither a greater nor a smaller number of islands than we find mentioned in the old Sagas of 600 or 700 years standing;* this certainty being, in my opinion, quite sufficient to entitle us to assume, that whatever may have been written about islands large enough to have been inhabited—represented likewise as having risen out of, and again sunk under, the sea, during that interval—is fabulous, except where such statements are supported by undeniable proofs.

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* Gunbjörn's Skerries form a solitary exception, in so far that we are prevented by the ice of later years from ascertaining their existence.

In conformity with this reasoning, the voyages of the Zeni were generally looked upon as an imposture so late as the middle of last century, although there did not at that time exist so many proofs of their falsehood as at present. This opinion was first combated by Forster, who, in his "Account of Discoveries in the Northern Regions," published in 1784, adduces arguments for the genuineness of the voyages. Eggers leans to the same opinion in his well-known prize essay, published in 1792; and, finally, Cardinal Zurla, who is still alive, has attempted to establish their genuineness beyond all doubt, in his treatises published in 1808 and 1818, entitled "Dissertazione intorno ai viaggi e scoperte settentrionali: di Nicolò e Antonio Frat. Zeni;" and "Di Marco Polo e degli altri Viaggiatori Veneziani più illustri." The same opinion has also been adopted by Zach, Buache, Malte Brun, Walckenaer, &c.; and of course such testimonies influenced M. de la Roquette in his late biographical sketch of these Venetians, which appeared in the "Biographie Universelle." Still I venture to combat this opinion, in asserting—

1st. That there never existed an Island of Frisland, but that what has been represented by that name in the Chart of the Zeni is the Feröe Islands.

2nd. That the said chart has been compiled from hearsay information, and not by any seaman who had himself navigated in those seas for several years.

3rd. That the "History of the Voyages of the Zeni," more particularly that part of it which relates to Nicolò, is so replete with fiction, that it cannot be looked to for any information whatever as to the state of the North at that time.

4th. That both the history and the chart were most probably compiled by Nicolò,* a descendant of the Zeni, from accounts which came to Italy in the middle of the sixteenth century, being the epoch when information respecting Greenland first reached that country, and when interest was awakened for the colony which had disappeared.

I. The first point has already been proved by Buache, Eggers, and Malte Brun, by arguments which I shall not repeat, nor shall I relate the voyage itself,—a task already performed by various others. I shall only add a few remarks on the subject.

Of the identity of Denmark, Norway, Sweden, and Scotland, there can be no doubt; as not only their relative positions, their outline, and the names of many places in them, but also their proper names in Latin, are decisive proofs of this. Of the five groups, Greenland, Iceland, Shetland, the Feröe islands, and the

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* Who, for brevity's sake, may be called Nicolò Zeno, Junior, or Nicolò Zeno, the Younger.

Orkneys, we recognise the proper names of the three which end in *land;* whereas the two last, called in those days Fœr-eyar and Orkn-eyar, are not to be found, these sounds being difficult to Italianise, or even to be at all caught or retained by any Italian ear. The name Gronlandia is applied, it is true, to quite a wrong place, where no land is to be found; but that the Engronelant in the chart, which in Antonio Zeno's account is moreover called Gronlandia, corresponds with the present Greenland, is proved so evidently by its shape, that I cannot conceive how Eggers could entertain a moment's doubt on the subject, or could believe that it was land on the opposite side of Baffin's Bay; the more so, as it is now ascertained that in that bay there is no St. James's Island in existence. The identity of Iceland is proved not only by the name Islanda, but further by the names of the bishops' sees, Scalodin and Olensis; that these two names in particular should be so easily recognised, and should bear so close a resemblance to the Latin names of the places, seems to indicate that the accounts respecting them were drawn from ecclesiastical sources. Though Shetland is called Estland, yet, in the first place, this is only a trifling transposition of the name in the spirit of the Italian language, and not exhibiting any greater deviation than is found in the other appellations given at different times to these islands,—such as Hialtland, Yealtaland, Yetland, Zetland, and Hetland; and besides, we recognise so many names here that we are almost tempted to believe that this was precisely the part of the chart best known to the author. We find, for example, Cledere, *i. e.* Queendal, Sumbercouit (Sumburgh Head), St. Magnus (St. Magnus Bay), Scaluogi (Scalloway), Bristund (Brassa Sound), Itlant (Fetlar), Lonibies (Lambness), Onlefort (Olna-Firth), and Oloford (Onze Firth).* And further, the placing of St. Magnus and Scalloway on the east side instead of the west side, naturally leads to the inference that these names were not copied from any other chart, but laid down from verbal depositions.

These points being admitted, the Orkneys must naturally be looked for between Shetland and Scotland; and this Eggers has done, but, in my opinion, not in a very satisfactory manner. He supposes that the name Contanis may be assumed as Continent, or, in other words, Mainland, the largest of the Orkneys. I, on the other hand, consider beyond all doubt that it means Caithness (formerly called Katanes), the most northern county in Scotland, a province which, from the evidence of the ancient code of laws called the Grágás, we know belonged, in the middle ages, to the crown of Norway. The only name I find to have a resemblance to any name in the Orkneys is Podalida, not unlike Pomonia, the principal island in the Orkneys, or Pentland (formerly Petland) the name of the strait which separates them from Caithness. Podalida corresponds with Pomonia in this respect also, that it is represented as a large island, surrounded by several smaller ones. This, however, is not quite satisfactory; we have, therefore, two groups remaining unaccounted for,—viz. the Orkneys and the Feröe Islands, one of which must of necessity be Frisland: unless we would suppose that a seaman, who had for several years navigated the Northern Sea in all directions, should have remained ignorant of the existence of the Orkneys and the Feröe Islands, and at the same time known and laid down a country which has since disappeared, and of which, moreover, all the inhabitants of the north in those ages had ever remained in utter ignorance; this appears to me so very highly improbable, that we may safely pronounce it to be impossible. If we subsequently compare names and positions, we shall find that Frisland can be nothing else than the Feröe islands; as the Rock Monaco, at the southern point, exactly corresponds to the position of the Rock Munk; in respect to the Feröe islands, as the names Sudero Colfo, Streme, and Andeford must of necessity be considered homonymous with Suderö Sound, Strömöe, and Andafer; and finally, as the absolute geographical position of Frisland corresponds better to that of the Feröe islands, than is the case with almost any of those places on the chart concerning the identity of which no doubt can be entertained. The south end of Frisland, for example, is placed in the latitude of the Feröe islands, whereas the northern extremity of Scotland is placed 2°, and all places in Greenland, Iceland, Shetland, Norway, and Denmark, are placed about 6° too far northward. In like manner, the eastern extremity of Frisland is laid down exactly as much to the westward of the Naze as the western extremity of the Feröe islands is distant from that point; whereas Iceland is placed 10°, and Cape Farewell 20° of longitude nearer to the Naze than they really are. This was, therefore, the place which Antonio Zeno, who knew as little about Frisland as we do, would, according to his brother's description, be most likely to fall in with when he went in search of him. It is further mentioned that Estland (Shetland) lies between Frisland and Norway, which is its relative position to the Feröe islands; and finally, it is expressly stated that Frisland was subject to the King of Norway; but as we know with certainty, from the Grágás Code, that no other islands were in this predicament than those now known to us, it follows that the country in question was the Feröe Islands.

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* Firth, or Fiord, was, in the ancient language of the North, called Fjörðr.

II.—As to the second point, it is in the first place hardly credible, that a seaman acquainted with the navigation of the Northern

Seas should have assigned so incorrect a relative position to the different places. For example, that Shetland (from which may be seen the Orkneys, lying close under the coast of Scotland) should be represented as situated near Norway, far distant from Scotland, and without any intermediate islands. The same fault, however, is found, to a greater or less degree, in all the maps published in the sixteenth century, which shows that the chart of the Zeni is, in this respect, a copy. We are perfectly acquainted from the Landnama-Book with every particular of Iceland in the thirteenth century, and we know that it was then just the same as now; how then is it possible that a seaman, who had resided there for so long a time, should represent it like an archipelago of several considerable islands? How could he have remained ignorant of the *native* names of the places, particularly of the harbours, and have only learned the *Latin* names of the island and its two dioceses? How could he give it a shape which, though it is called by Malte-Brun, in his " Précis de la Géographie universelle," " bonne à l'exception de la partie Nord Ouest," in truth resembles any other place as much as Iceland? How could he lay down to the north-east of Iceland a continent upon which he pretends to have been, when we know that in that direction there exists no continent, but only the island of Jan Mayen? And finally, how could he have been in the Feröe islands, and yet represent them as one large island surrounded by some smaller ones? The whole chart bears the most palpable marks of having been compiled by a person who had never been at the places themselves, and who knew nothing of either the language or the history of the North; for the Sagas and Sailing Directions prove, that in those days the inhabitants of the North had much juster ideas of the relative position of places, and that they knew, for example, that a line drawn from Bergen, between Shetland and the Feröe Islands, would pass about sixty geographical miles to the southward of Iceland. The chart is dated 1380, an epoch at which Zurla has proved that both Nicolò and Antonio Zeno were in Italy; which shows that they had not drawn the chart at the places themselves,—for as to the possibility of their having antedated it, it is to be presumed that in those days there was as little inducement as there is now for the framer of a chart to publish it as older than it really was. Finally, the comparative correctness of the delineation of Denmark and Norway is the best proof that the chart was not drawn in 1380, but about the middle of the sixteenth century. Zurla himself mentions that in the Isolario of Benedetto Bordone, published at Venice in 1534, Norway and Greenland are very erroneously laid down,—a topic to which we shall have to return hereafter. The exiled Archbishop of Upsala, Olaus Magnus Gothus, published at Venice, in 1539, a map of the three Scandinavian kingdoms, which I have not seen, as it appears doubtful whether any copy of it remains in existence; but undoubtedly this map, and those published at Antwerp, particularly those of Ortelius, were the first that gave a tolerably correct representation of these countries, an accurate knowledge of which it was impossible for the Zeni to have procured at any of the places visited by them,—viz. Frisland, Estland, Iceland and Greenland.

III. & IV. As to the fabulous parts of the narrative, it is difficult to select one passage in preference to another for refutation, the whole being a tissue of fiction. If we judge from the statement of Nicolò Zeno, junior, (which was published along with a chart, by Marcolini, in 1558,) Nicolò Zeno did not commence his voyage till immediately after the conclusion of the peace with the Genoese, on the 24th of August, 1381, and subsequently Antonio followed him in consequence of a letter which reached him at Venice, from his brother in Frisland. But if we are to judge from the chart, they had already been in the North in the year 1380. From the above, as also from subsequent letters, we are to infer that there existed a communication between Frisland and Venice, which would lead us to the further inference that Frisland was a place well known in the north; but this we know with certainty was not the case; and then how small is the probability that a series of letters written from the Feröe Islands should regularly find their way to Venice. If we even suppose that this were possible by means of pilgrims and merchants by the way of England and Bruges, still Zurla's own data will not admit of so slow a conveyance. For, according to him, Nicolò cannot have left Venice before the year 1390; and it is certain that in 1406 Antonio was already dead. Of that interval Antonio is said to have spent fourteen years in Frisland. There remain, therefore, scarcely two years for Nicolò to have completed his perilous voyage, to have been wrecked, to have made his first brilliant campaign, which ended in the conquest of Frisland, and to have forwarded the report thereof to Antonio, in Venice, who, on the other hand, is said to have made the necessary preparations for a similar voyage, and to have actually performed it, (although, according to the description, it was both tedious and dangerous,) to have found Frisland, to have returned from thence to Venice, and to have died there, and all this within the above-mentioned brief interval of two years. Even now-a-days this would scarcely be allowed to range under the class of possibilities; and yet Zurla, when making the computation, says, "Cosi mirabilmente tutte l'epoche si accordano."

Yet it is on the authority of such letters, which Nicolò Zeno, junior, pretends to have had in his possession, that he has written the narrative; from the same letters he must have drawn his dates, as such could not be omitted in a correspondence carried on between the Feröe Islands and Venice, and a solitary error in this respect could easily be detected, as there were several letters. Now, as the dates of these letters correspond exactly with the time at which Zurla has clearly proved that the brothers were in Italy, it follows that the letters from Frisland were either fabrications, or that they never existed. Cardinal Zurla having thus shown that Nicolò Zeno's narrative is false, it only remains to demonstrate from historical facts, that the cardinal's hypothesis of the voyage having been performed later does not hold good. Our principal authority for the age of the brothers is to be found in the life of the celebrated Carlo Zeno, written with considerable detail by his grandson, Jacopo Zeno, who died in the year 1481, when Bishop of Padua, but who in 1458—the period we allude to—was Bishop of Feltre and Belluno. This prelate, who was born in 1417, must necessarily have known the children of Nicolò and Antonio, and consequently it is quite inconceivable that he should be ignorant of their exploits and letters, if these were anything else than fiction; and yet, in his dedication to Pope Pius II., when alluding to his family, he thus expresses himself:—"Most holy father! this family was always eminently distinguished by men who made themselves famous as citizens, acquiring glory abroad and at home, in war and in peace, and of whom many have, as commanders by sea and by land, earned for their country pre-eminent advantages,"—without making any the least allusion to the remarkable discoveries in question.

No mention whatever is made of any of Carlo's brothers, either in his life, which is written with great detail, nor yet in the funeral oration pronounced in honour of him in 1418, by Leonardo Giustiniani, in which, after portraying the merits of Carlo and of his father in the brightest colours, the orator simply adds, "I will not say anything of his children or of his nearest relations."

All that we gather from the life of Carlo is, that the ten children were born in rapid succession; and, as their father married in 1326, we may assume that Nicolò, as the eldest brother, was born about the year 1328. In the annals of Venice mention is made of Nicolò Zeno as one of the most opulent patricians; as having been an elector at two elections of Doges; as having been ambassador of the republic; and, finally, on the 26th November, 1388, he is mentioned as one of the syndics who were appointed to take possession of Treviso.*

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* This is the opinion of Cardinal Zurla, but which I by no means believe to be correct. What he finds mentioned in the Annals of Venice, from 1365 to 1388, he

It is after this period, consequently after he had passed the 60th year of his age, that he is said to have formed the design of making a voyage of discovery. After having suffered shipwreck at the Feröe Islands, he finds them ravaged by a foreign potentate, called Zichmi, Lord of Porlanda and Sorano, the former of these being distant only half a day's sail from Frisland. If Frisland was not the Feröe Islands, then it and the other countries mentioned have all sunk under the ocean; but if, on the other hand, it is assumed to be the Feröe Islands, which is beyond doubt the only supposition we can form, then the whole story is false, since the countries so described by Zeno bear no resemblance whatever to what the Feröe Islands now are, or ever have been; and as to the war asserted to have been waged between Zichmi and the King of Norway, this assertion is the less entitled to belief from the circumstance that there was then no king in Norway, that country being at that period under the government of Queen Margaret. Forster's opinion that Zichmi might have been Henry Sinclar, Earl of the Orkneys, is altogether destitute of foundation, as that lord, on whom the said earldom was bestowed in 1380 by King Haagen, both in 1388 and 1389—as a Norwegian councillor of state—signed the act by which Eric of Pomerania was acknow-

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attributes entirely to the hero of our history, although he at the same time informs us, on the authority of a MS., "Il Campidoglio Veneto," by Girolamo Capellari, which still exists in the library of St. Mark, that in the year 1379 there were in Venice two other persons of the name of Nicolò Zeno, for which reason our hero was by way of distinction called Nicolò quondam Ser Dracone. Admitting this, it appears to me that the passages occurring in the Venetian Annals refer to three different persons of the name of Nicolò Zeno; and of these,

1. The first was ambassador to the sultan in 1349, was amongst the forty-one electors at the elections of the Doges Dolfino, Celsi, and Cornaro, in 1356, 1361, and 1365, and was sent to accompany the pope from Marseilles in 1367.

2. The second was, in 1379, captain (master?) of a galley commanded by Victor Pisano and Carlo Zeno.

3. The third, Nicolò Zeno quondam ser Dracone, does not occur in the history of Venice before the year 1382, when his brother Carlo had saved the republic, which so much increased the reputation of the family, that Carlo was appointed governor of Negroponte, Marco, ambassador to the King of Sicily, and Nicolò, ambassador to the Duke of Ferrara: during this same year he was one of the electors at the election of the Doge Morosini. In 1388, on the 14th December, he took possession of the city of Treviso as syndic and provenditor.

If, as stated by Zurla, an old manuscript mentions a Nicolò Zeno as one of the most opulent citizens of Venice, I suppose this person to have been the eldest of the three, or the one first mentioned in this note; inasmuch as at the election of Cornaro in 1365, he is styled Zeno il grande, whereas the ten children of Pietro Dracone were left by him in great poverty.

He who was master of the galley under the command of Carlo Zeno could not have been his elder brother, Nicolò, the head of the family; a subordinate station of this sort was, however, filled at the same period by Donato Zeno and Pietro Zeno, who were both made prisoners at the battle of Pola, on the 29th May, 1379.

All doubts on this subject would have been removed, if Zurla had communicated the genealogy of this numerous family with a little more minuteness. To me it appears evident beyond all dispute that the third-mentioned Nicolò Zeno was neither the man of opulence nor the seaman; and yet he must have been both to enable him to undertake and perform the voyage which has been ascribed to him.

ledged true heir of the realm, and therefore at that time could not have been in rebellion against the crown. Neither is there any reason for supposing that his earldom, which comprehended Shetland, was in the meantime attacked and completely ravaged, and yet the Danish history make no allusion to any such circumstance; more especially when we again in 1397 find that Jonas, Bishop of the Orkneys, signed in Calmar the Coronation Act of Eric of Pomerania, which shows that the connexion between the islands and the mother country had continued without interruption.

As to the attack on Iceland—independently of what has already been said of the non-existence both of the uninhabited Grislanda, and of the other seven islands, which Nicolò Zeno is said to have plundered—it must be remarked, that the annals of Iceland at that period are much too circumstantial to have passed over in silence either such an attack, or the building of a fort such as Nicolò is said to have built on the island of Bres. Finally, the names ascribed to the seven islands are not at all northern, but are evidently the fabrication of a person entirely unacquainted with the northern languages.

With respect to the voyage to Engrovelant (in the chart called Gronlandia), this, like all the other parts of the narrative, bears the most evident marks of fiction. No continent exists in the direction indicated by Zeno, and few will be inclined to believe with Estnip, that there existed convents in Greenland out of the bishopric of Garde, that is to say, out of the Icelandic Colony. That this colony was not situated at Gæle-Hamkes land, or in Scoresby Sound, but near Cape Farewell (whether to the west or to the east of it), is certain, and therefore no navigator could steer north, or a northerly course, to reach it, but he would necessarily be obliged to steer to the westward. As to the volcanos and hot springs, which served to warm the houses, to cook the victuals, and to make the fruits of the south thrive in the latitude of 74°, I do not think this part of the romance worth a refutation. It is clearly nothing but a plausible selection from Olaus Magnus's fables about the north, particularly those regarding Iceland and Hekla; while no mention whatever is made of what in those days ought to have struck every Venetian with astonishment, and which, therefore, Nicolò Zeno could not fail to have recorded, I mean, that when he, in the month of July, steered northwards from Iceland, he found no longer any appearance of night, but, on the contrary, an uninterrupted day!

The Venetian patrician—in the sixty-fifth year of his age—must have felt that for his great merits he received their appropriate reward when dubbed a knight by Prince Zichmi himself!

As to the exploits of Antonio Zeno, they certainly have a less fabulous appearance, and he cannot be held responsible for the accounts about Estotiland and Drogeo given him by the fishermen of Frisland. But with respect to the vanished island of Icaria, and also King Dedalus of Scotland and his son Icarus, the very names prove that he did not know enough of northern mythology to enable him to extract the materials of his fables from it. By what means, with a north-east course—that is, running right before a south-west wind, he could fetch the southern cape of Greenland, it is difficult to conceive, unless we suppose that he took his departure from Newfoundland; accordingly, both Zurla and the other champions of the voyage maintain that Icaria was Newfoundland. But they forget that Zeno, in the beginning of the voyage, steered for six days with a fair wind due west from Icaria, which it is quite impossible to do from Newfoundland. The courses, west during six days, and north-east three days, both with a fair wind, indicate the situation of Icaria to be (in concordance with the chart) to the eastward of Cape Trin (Farewell), the place he came to, which proves that also this island had no existence but in the narrative of Zeno. On the other hand, the satisfactory explanation of which the Cape and Harbour of Trin are susceptible deserves to be particularly noticed. In Zeno's chart, for instance, we find the Cape Af and the Firth Auer placed in the precise part of Greenland where the Cape Af-Hvarf must have been situated, if we suppose the position of the ancient eastern colony to be that of the present district of Juliane's Haab; and, following up this supposition, Cape Trin corresponds with Herjolfnæs, and the harbour of Trin with Sandhavn, mentioned by Ivar Bere in his sailing directions as lying between Herjolfnæs and Hvarf, and as that harbour in Greenland which was most frequented by Europeans.

In this respect, therefore, Zeno's chart agrees better than any other with the accounts we have from "the olden time," and, with respect to the general outline of Greenland, it is more correct than any known chart published before the sixteenth century. This would be a strong proof of the genuineness of the chart and of the voyage, if Nicolò Zeno the younger had not, in 1558, any other authorities from which to lay down Greenland, than the common maps of that period. But it is easy to find reasons which make it highly probable that he had verbal sources of better information, and quite certain that he was able to avail himself of written sources not generally known. As he was so great a proficient in geography, that his own countrymen looked upon him as the greatest geographer of his time, nothing is more probable than that, in order to get information concerning the northern regions, he applied to the higher Catholic clergymen who were banished at this very time, and had repaired to Italy, and who, of course, were able to communicate more correct ideas of the north. Among them may be mentioned Walkendorph,[*] at that time the best-informed individual on the subject in question, and who died at Rome in the year 1533; and the brothers Olaus and Johannes Magnus of Lindkioping and Upsala, the former of whom published at Venice, in the year 1539, the map already alluded to, and which may very well have contained some information on this head.[†] Both brothers, also, wrote about the North during their residence in Italy. This is the only way of explaining how the map alluded to by Eggers (which is preserved in the University Library of Copenhagen, and which was engraved in Venice in 1562) should represent Scandinavia so much more correctly than any other contemporary map; and when we compare this map with similar ones, published previously at the same place, we see clearly what a great advance had been made in this part of geographical knowledge, precisely within the period of a few years before Zeno published his chart.

That Zeno, moreover, in the framing of this chart, had also the assistance of earlier models, may with certainty be inferred from the following circumstance. In the University Library of Copenhagen, there is a very old MS. map, in which Greenland is laid down exactly as it is laid down in Benedetto Bordone's "Isolario," of which work Zurla has mentioned and described two editions in 1526 and 1534, while that in the Royal Library of Copenhagen is of 1547. This map contains what we do not find in that of Bordone, viz., names, and these names agree almost uniformly with those in Zeno's "Greenland," follow each other in the same order, and the few that are missing are precisely those of the places which the Zeni are said to have visited! Now, as it is not to be imagined that, after the publication of Zeno's chart, anybody would take an outline of Bordone to fill up with names supplied by Zeno, the natural inference is that the original of this map has served as a model—to Bordone for his outline, and to Zeno for his names;* although the latter himself says that he supposes that Zichmi has discovered and surveyed the country on both sides, "as he finds it minutely described in the Navigation Chart." The names in Zeno's chart which are not to be found in the map now mentioned are, the Convent of St. Thomas and Cape Trin, and also the two westernmost firths on the coast, which, consequently, have been added by Zeno, and which are precisely the only two of which the names are to be found in the ancient descriptions (or chorographies), namely, Diurfiumen (Dyrefiord) and Pederf (Pedersvig). At an arm of the sea towards the north-east, the map has the two Capes Cadi and Na; these Zeno has transferred to the south-east coast: at Cape Farewell we find an island, Margarester, which Zeno has omitted, but which has been inserted again by the later Flemish geographers, and placed by them to the southward of the Convent of St. Thomas. Lastly, we find to the westward of Cape Farewell a firth called Spichbod, which Zeno has omitted, being the only instance where the name bears the mark of Dutch origin. In the "Memoir of Sebastian Cabot," published in 1832, it is shown that Ramusio, who had hitherto uniformly been cited as an authority in favour of the genuineness of these voyages, is very far from being so, as they are not contained in the first edition of his second volume, published in 1559. But in the third edition, published in 1574, they are adopted† to their full extent, together with their splendid descriptions of the riches of Estotiland, which last part of the story, however, it was thought fit to leave out in the fourth edition, published in 1583, Frobisher having in the meanwhile performed his voyages, and, as we all know, without finding any gold.

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[*] As early as 1520 he sent to Pope Leo X. the head of a northern sea monster as a natural curiosity.

[†] In favour of this supposition it may be mentioned, that it is by no means certain that the map of the northern regions in Fickler's translation of the work of Olaus Magnus, printed at Basil in 1567, corresponds in all points with the map which that prelate himself published at Venice in 1539, although many authors have adopted this opinion (in the Latin original, it may be observed, there is no such map, and in the Italian translation only an imperfect one). It is argued in behalf of those who maintain the identity of the two maps, that in the map which Olaus Magnus annexed to his brother Johannes Magnus's "Gothic History," published by him in 1557, the delineation of Scandinavia corresponds exactly with the delineation given in Fickler's map. But, on the other hand, Fickler's map does not correspond with the text of the original; for example, we look in vain for the rock Huitsark, of which so much mention is made. It may here be mentioned, that this is the first map which shows an open sea to the northward of Norway—a navigation first opened by Willoughby and Chancellor in 1553, and which Ramusio mentions was still imperfectly known. To this map we are also indebted for the imaginary town of Alba in Greenland, and I am not aware of the existence of any older map on which the Feroe Islands are laid down.

As Ramusio died on the 10th July, 1557,‡ and as he in another place expressly says, that nobody can dispute the title of Columbus to the first discovery of America, and that he envies Genoa for having produced such a son, it is evident that he is by no means an authority for the genuineness of those voyages; on the contrary, this is a proof that, up to his time, there did not exist in Venice any documents to prove it, or else so able and assiduous an inquirer, who was at the same time secretary to the Council of Ten, and had access to all the sources of information, would not have failed to use them to the best advantage. Ramusio further mentions Catarino Zeno in terms of praise, and, according to the statement of all authors who have treated of the subject, he regretted that he had not been able to procure a copy of his "Travels in Persia," that work having become so rare, that in his time not a copy was to be found in Venice. This opinion is deduced from the following expressions of Ramusio:—"Cosi la fortuna ci fosse stata favorevole a farne venire nelle mani il viaggio del magnifico Mr. Catarino Zeno il Cavalier, che fu il primo ambasciatore ch' andava in detta provinzia al Signore Ussumcassano; ma la longhezza del tempo, auvegne che fossa stampato, ha fatto si, che l' habbiamo smarrito."—*i. e.* "We were fortunate enough to get possessed of the Travels of the noble knight Catarino Zeno, who was the first ambassador to Ussumcassan of Persia; but although it was printed, the length of time has been the cause of our losing it."

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* A trifling circumstance enables us to distinguish with certainty between the original and the copy. The map in the University Library has Hestlefl where Zeno has Elestre. Here it is easy to see that the Italian, in copying, has dropped the *h*, as appearing to him harsh and unnecessary. We also find in Zeno's "Iceland" the following names corresponding with names in the aforesaid map—Olensis (*i.e.* Holum) corresponds with Holesis (here again the *h* is dropped), Honos with Hanos, Tuhos with Turhos, Dos with Dos, and Nodei with Naderos.

† But in my opinion not, as the English author supposes, with a view of giving them to the world as part of Ramusio's own work. In the edition of 1574, they, along with some other voyages, are formally announced as supplementary, being probably the work of the editor, Tommaso Giunti; among these other voyages, or travels, is Herberstein's "Travels in Russia," with an introduction written at Vienna in 1559, and which, consequently, could not have been inserted in the first edition, which was published that very same year at Venice.

‡ Camus, Memoire sur la Collection des grands et des petits Voyages.

In the above sentence there is, strictly speaking, no meaning; for the book being printed could not surely make it more difficult to be lost by a collector like Ramusio, who in this case would naturally have taken notice of the remarkable circumstance that his missing copy was the last, and that not another was to be found —a thing that, with regard to time, place, and object, is quite incredible; and besides, if we were to suppose this to be the meaning of the sentence, the construction would scarcely be correct, for then the words "auvegne che fossa stampata" ought to have closed the period.

But if for "auvegne" we substitute "avanti" (*i.e.* "before" for "although"), the construction will be correct, and the meaning of the sentence intelligible, though quite different from that hitherto adopted. The meaning will then be, that the long time it took before Ramusio's own work got printed, caused him to lose the manuscript of Zeno's Voyage; and this meaning is the more natural, as in reality the printing of his work encountered singular obstacles. There exist, for instance, editions of the first volume of the years 1550, 1554, 1563, 1588, and 1613; of the second, of 1559, 1564, 1574, and 1583; and of the third, of 1556, 1565, and 1606. The reason of the third volume being published before the second is explained by Giunti in his preface to the second volume, by the death of Ramusio, and the burning of his own printing-office; and it is precisely this volume which contains the above-mentioned expressions of Ramusio. If now it be permitted to suppose, in a posthumous work, an error of the